NASA CR-
147431

FINAL REPORT
SPACE SHUTTLE/ FOOD SYSTEM STUDY

FOOD & BEVERAGE PACKAGE DEVELOPMENT

MODIFICATION 8S

JANUARY 1976

prepared for

NATIONAL AERONAUTICS and SPACE ADMINISTRATION
Johnson Spacecraft Center
Houston, Texas 77058

Contract NAS9-13138

Prepared by

THE PILLSBURY CO. Pillsbury

FAIRCHILD REPUBLIC DIVISION

(NASA-CR-147431) SPACE SHUTTLE FOOD SYSTEM STUDY: FOOD AND BEVERAGE PACKAGE DEVELOPMENT, MODIFICATION 8S Final Report (Pillsbury Mills, Inc.) 117 p HC $5.50 CSCL 06K G3/54

N76-17823

Unclas
14168

FINAL REPORT
SPACE SHUTTLE/ FOOD SYSTEM STUDY

FOO' & BEVERAGE PACKAGE DEVELOPMENT

MODIFICATION 8S

JANUARY 1976

prepared for

NATIONAL AERONAUTICS and SPACE ADMINISTRATION
Johnson Spacecraft Center
Houston, Texas 77058

Contract NAS9-13138

Prepared by

THE PILLSBURY CO.

FAIRCHILD
REPUBLIC DIVISION

Table of Contents

1.0 INTRODUCTION

Studies conducted under the basic contract and ensuing contract modifications have resulted in the development of a new, highly utile rehydration package for foods in zero gravity. Rehydratable foods will become more acceptable as a result of their overall rehydration capability and improved palatability.

This new package design is greatly enhanced by the specified space craft condition of atmospheric pressure; the pressure differential between the atmosphere and the package carries the functional responsibility for rapid food rehydration without excess package manipulation by the consumer.

Crew acceptance will further be enhanced by less manipulation, hotter rehydration water temperatures and the ability to hold the foods at preparation temperatures until they are consumed.

At the conclusion of the last modification, where feasability was proven, it was determined that the package design could be optimized and finalized. This report covers the package design accomplished during this modification.

2.0 OBJECTIVES AND PLAN

While the primary objective of this modification was to accomplish the final design of the rehydratable food package, there were other equally important tasks accomplished. These tasks were equally divided between

2.0 Con't.

the Pillsbury Company and Fairchild Republic (sub contractor).

2.1 Optimized Design

A task to optimize the design with respect to the galley and the galley water system was assigned to Fairchild with primary responsibility and with Pillsbury providing support.

2.2 Package Material Specifications

The material specifications for the package film, base and septum were assigned to Pillsbury with sole responsibility.

2.3 Package Assembly (Process Specifications)

The process for package assembly was assigned to Pillsbury with primary responsibility and with Fairchild providing support with regard to optimum jigs and fixtures associated with the assembly.

2.4 Product Specifications

Product specifications for 15 rehydratable food items were the sole responsibility of Pillsbury. These items covered a range of package fills and product densities. Due to a compression of time parameters, certain measures of expediency were taken to fulfill the requirements of this task.

2.5 Manufacturing Fixtures

The design of the fixtures was the primary responsibility of Pillsbury with Fairchild providing

support and drawings. The fixture fabrication was the primary responsibility of Fairchild.

2.6 Package Interface Control Document

The I. C. D. was the primary responsibility of Pillsbury with Fairchild supporting with data and format.

2.7 Prototype Manufacture

Manufacturing the functional prototypes were the sole responsibility of Pillsbury. The prototypes inculded entees, side dishes and soups.

2.8 Skylab Bellows Drink Pack Feasibility Study

A study directed at determining the design feasibility and compatability with the galley water system was the primary responsibility of Fairchild with Pillsbury providing support.

3.0 RESULTS

To accomplish the tasks for this modification a team of sceintists was assembled from Pillsbury and Fairchild which included, package engineers and food scientists from Pillsbury as well as related engineers from Fairchild. A detailed description of tasks results follows.

3.1 Package Specifications

Prior to finalizing and writing the package specifications, a variety of tests were designed and conducted on hand made package assemblies. A compression of the modification time frame created a situation

where the test-parameters as outlined in the statement of work had to be altered. Such long term tests as storage, water vapor transmission rates of the film and before and after (storage) ground handling and transport loading tests were traded off for a series of package functionality tests.

These tests included: septum utility tests, package uniformity and size parameters, measurement of internal package pressures after handling, measurement of septum sealing ability, measurement of force requirements for injection needle insertion and withdrawl. And finally a subjective determination of product uniformity and quality of rehydration.

To accomplish this testing, a temporary package sleeve forming fixture and a package assembly jig were fabricated to be used in assembling, filling and sealing test packages. In addition, test rigs were built by Fairchild to accurately perform and measure the tests as outlined. The detailed work and test results are found in Appendix I.

3.1.1 Optimum Package Design Selection

A series of design trade offs were accomplished by Fairchild which resulted in base modifications and minor alterations to package assembly methodology. The base modification was to provide a keyway in the base which assures a safe method of presenting the septum to the water injection needle. The work from this task was presented orally at a joint NASA, Pillsbury,

Fairchild meeting held at the NASA on 6/25/75. The documented materials are found in Appendix II.

3.1.2 Package Material Specifications

Package material specifications were drafted and tested for ability to purchase from suppliers. These specifications for the package film, the package base and the package septum are documented in Appendix III.

3.1.3 Process Specification (Package Assembly)

The package assembly, filling and sealing process specification was written and tested for functionality. This process specification is documented in Appendix III. (See also Appendix IV).

3.1.4 Product Specifications

Time constraints imposed by shortened delivery times prohibited the complete development of quality foods and resulting specifications. Since the primary objective of this modification was to test the package parameters, certain quality foods were purchased from Oregon Freeze Dried Foods for inclusion in the program as a measure of expediency. Some of these foods (the entrees) were manufactured to military specifications as follows:

a) escalloped potatoes with pork
MIL-E-43749A

b) chili con carne
MIL-C-43287C

c) beef stew
MIL-B-43404B

d) beef with rice
MIL-B-43750A

e) chicken and rice
MIL-C-43289B

In addition, six side dishes and fruits have been purchased from Oregon Freeze Dried Foods for inclusion in the program. These freeze dried foods have no accompanying specifications. A list of these foods follows:

a) cooked carrots
b) green peas
c) cooked whole kernel corn
d) apple slices
e) plum slices
f) pineapple pieces

Specifications were developed for the soups. These foods were manufactured at Pillsbury and were based on existing NASA formulae as well as technology developed at Pillsbury. A list of these foods and specifications follows:

a) split pea with ham soup
specification Guide Number 1
b) chicken and rice soup
specification Guide Number 2
c) cream of tomato soup
specification Guide Number 3
d) cream of potato soup
specification Guide Number 4
e) beef and noodle soup
specification Guide Number 5

The specifications noted above are detailed in Appendix IV.

3.1.5 Manufacturing Fixtures

A complete set of manufacturing fixtures was designed and fabricated capable of:

1) Forming and shaping the package sleeve (forming mandrel).

2) Forming the base (heat, vacuum forming block).

3) Assembling the sleeve, base and septum (forming mandrel).

4) Filling the package (sealing Jig).

5) Sealing the package (sealing Jig).

Detailed drawing on the jigs and fixtures are in Appendix V.

3.1.6 Package Interface Control Document

An interface control document for the rehydratable food package has been prepared. The detailed document is in Appendix VI.

3.1.7 Prototype Manufacture

Prototype (functional) packages were manufactured for the 16 food items previously discussed. These items were packed and shipped to the NASA. The following is a listing of items and the quantity shipped:

ITEM	SHIPPED
1) Escalloped potatoes with pork	5
2) Chili con carne	5
3) Beef stew	5
4) Beef with rice	5
5) Chicken and rice	5
6) Carrots	10
7) Green peas	10

ITEM	SHIPPED
8) Corn	10
9) Apples	5
10) Plums	5
11) Pineapple	10
12) Split pea with ham soup	5
13) Chicken and rice soup	5
14) Cream of tomato soup	5
15) Cream of potato soup	5
16) Beef and noodle soup	5

3.1.8 Modified Skylab Bellows Drink Package

A feasibility study to determine the adaptability of a modified Skylab drink package was performed by Fairchild. It has been determined that this package can be modified for exceptional performance when used in conjunction with the needle and septum water delivery system. The details of this study are in Appendix I.

4.0 RECOMMENDATIONS

The rehydratable food package as currently configured is essentially suitable to the Shuttle mission. It is light weight, simple to rehydrate, and leakproof. The attained seal-off pressure of 3300 N/m^2 (25m Hg) is adequate, but can probably be extended downward by a factor of ten. While this is perhaps not necessary from the viewpoint of good rehydration, it would extend the shelf life of the food. Shelf life

could not be determined because of the shortness of the test period. The only prediction is that shelf life is at least six months. Longer test intervals should be established to predict shelf life.

The Skylab drink cup could be used as is with proper design of the needle probe assembly. This approach may require some tighter control of food package production to limit septum thickness. Development of a new reusable drink valve together with the Skylay cup modified with a septum may be a better solution. The new reusable valve could be engineered to be leakproof and easier to use thus eliminating the problems encountered on Skylab.

The design of the food package and septum, and drink device is so closely related and interdependent on the interface with the water system probe, it is recommended that the galley designer and the food package designer maintain a continuing interchange of data to assure mutual compatibiltiy.

RD008V2904

FOOD AND BEVERAGE PACKAGE DEVELOPMENT SHUTTLE FOOD SYSTEM STUDY

16 October 1975

FAIRCHILD

Fairchild Republic Company Farmingdale, L.I. New York 11735

Prepared for
The Pillsbury Company
Minneapolis, Minnesota 55414
under

TPC Contract P.O. 33349

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

1.0 SUMMARY

A test program was completed in which a newly developed rehydratable food package was evaluated for suitability for the Shuttle Orbiter galley. Rehydration proved to be a simple operation using a needle probe/septum technique. The septum sealed the package satisfactorily, neither admitting air or leaking water. The food was uniformly rehydrated after a suitable holding period and required no crew manipulation other than a slight stirring in some cases.

Modification of the Skylab drink cup was investigated to make it compatible with the needle probe rehydration system. Some additional development may be required.

2.0 INTRODUCTION

The Pillsbury Company has developed a new food package for dehydrated food for use in the Space Shuttle program. This package is light weight plastic sealed under vacuum. Water for reconstitution of the food is introduced by a needle through an elastomeric septum. This provides a leakage seal and eliminates the requirement for a valve assembly. This program was undertaken to test the concept by rehydrating various food types under conditions of the Shuttle insofar as they could be duplicated.

A water system designed for this new food package must also be able to dispense water for drinking. Rather than develop a completely new drink device, possible modifications to the existing Skylab bellows drink cup were investigated.

3.0 SCOPE

The food package program was concerned with measuring those physical properties important for the successful rehydration under zero-g conditions. This includes the interface of the package with the needle probe, the possibility of leakage, the quality of rehydration, and the mechanics of food consumption. Food engineering was not considered.

The drink cup program studied methods for adapting the existing Skylab device to the water probe designed for the food packages. Only the introduction of water was considered; the drink valve was not addressed.

4.0 OBJECTIVES

4.1 Measure Package Uniformity

The Shuttle water system should make few demands on the user for the proper introduction of water and should be virtually automatic. This requires a certain uniformity of the package to assure that the needle penetrates the septum properly and that the needle does not penetrate the food wrapper thereafter.

4.2 Measure the Package Internal Air Pressure

At zero-g, air in the package or introduced with the water will interfere with rehydration since the air may displace the water at some portions of the food. It may also create problems by causing package distortions which interfere with the galley oven. The quantity of air will be estimated to determine the adequacy of the seal-off pressure and the food wrapper material.

4.3 Measure the Septum Sealing Ability

The possible air leakage into the package on needle insertion, or the leakage of water through the septum during food handling will be determined.

4.4 Measure Forces Required for Needle Insertion and Withdrawal

The resistance of the food package and food mass to the needle penetration and motion will be measured to assure that they do not present a problem to the needle assembly or the user at zero-g.

4.5 Determine Uniformity of Rehydration

The spread of water from the septum to the rest of the package will be checked for evidence of dry areas or pooling of water.

4.6 Determine the Quality of Rehydration

The quality of rehydration in the food package under Shuttle conditions will be compared to conventional rehydration techniques.

4.7 Skylab Drink Cup Modification

Methods of modifying the Skylab bellows cup to be compatible with the water system will be studied.

5.0 TEST EQUIPMENT

5.1 Rehydration System

Figure 1 illustrates the rehydration system used in the study. It includes a food package holder for positioning and restraining the package, a needle support which aligns the needle with the septum and moves the needle axially with an adjustable stroke, and a water reservoir which can be pressurized to the range on the Shuttle Orbiter. The forces required for needle penetration and withdrawal can be measured by attacking a force gauge to the needle support as shown.

5.2 Septum Leakage Measurement

The rehydration device is modified for the measurement of septum sealing ability by removing the food package holder and replacing it with a septum specimen test chamber shown in Figure 2. The chamber holds a disc of food package wrapper on which septum material specimen has been bonded. For measuring air in-leakage the chamber is evaluated and sealed off. The septum is then punctured and the chamber pressure change is recorded as a measure of air leakage.

For measuring water leakage the platform with the test chamber and needle support is rotated 90° so that the septum is at the bottom of the test chamber. The package film is covered with a layer of water and the chamber is pressurized. The pressure at which water begins to leak is a measure of the septum sealing ability.

5.3 Food Package Vacuum Measurement

The amount of air remaining in the food package is estimated by placing the package in a vacuum system with a transparent bell jar and slowly lowering the chamber pressure to the point where the package wrapper expands due to differential pressure created. The pressure at which the wrapper lifts off the food surface is recorded.

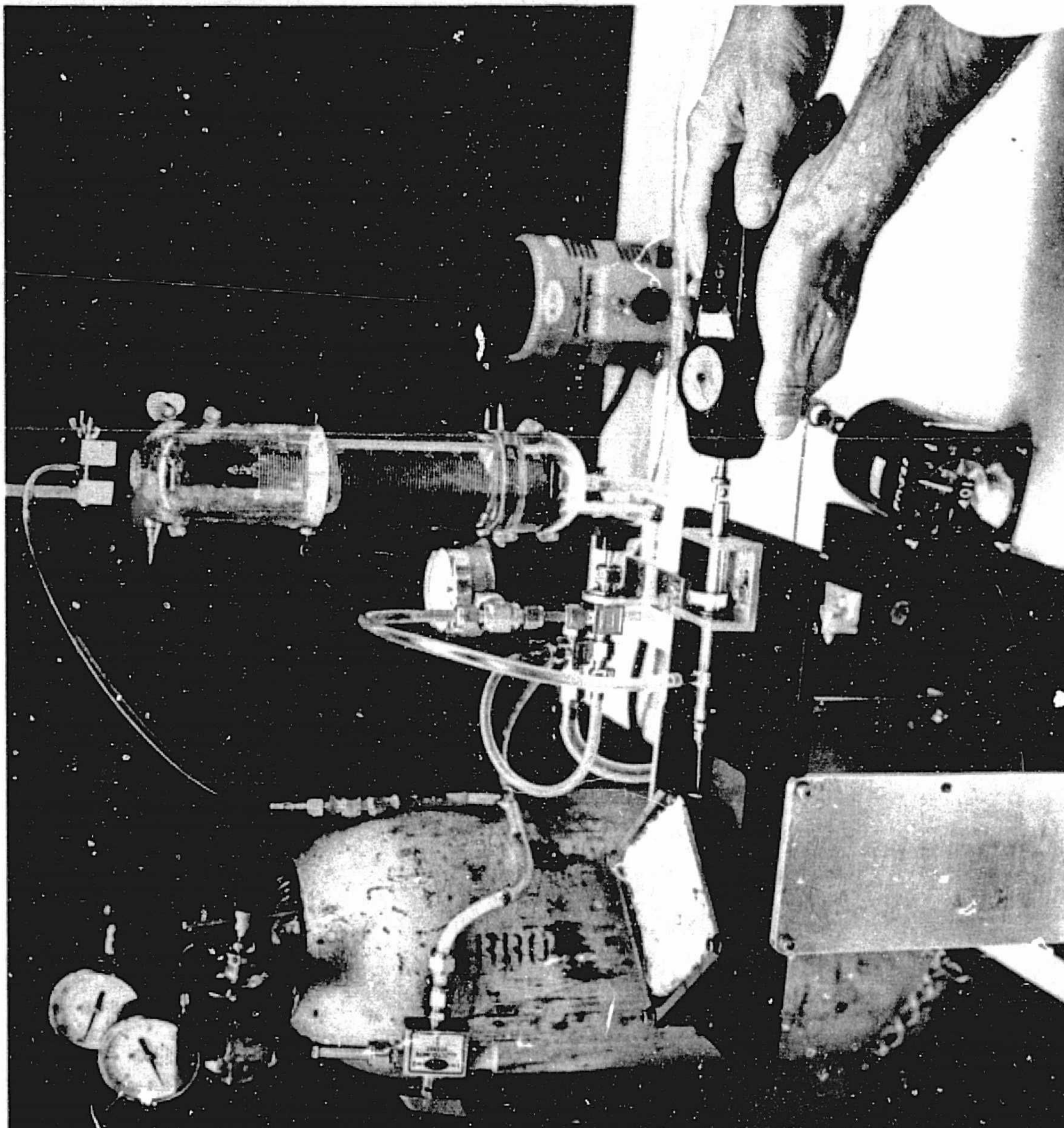


Figure 1. Food Package Rehydration Apparatus with Needle Force Measurement

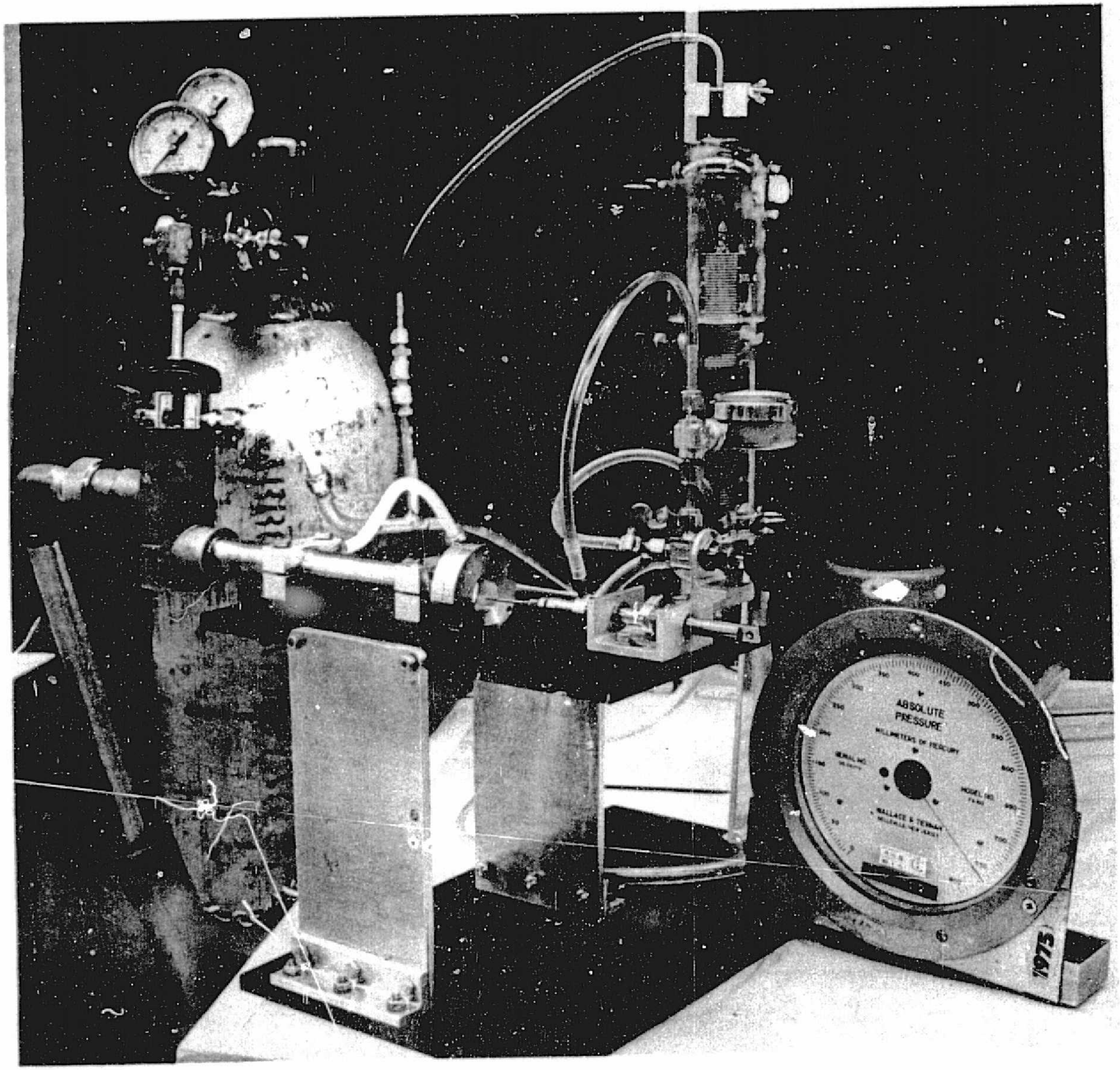


Figure 2. Septum Leakage Measurement

6.0 RESULTS

6.1 Food Package Dimensional Properties

The average height of 54 food packages was 0.0257m (1.01 inch) with a minimum of 0.0229m (0.9 inch). The septum center is located about 0.0095m (0.375 inch) from the bottom surface. The package surface is not smooth since almost one atmosphere differential pressure contours the wrapper surface to the food surface. The extent of the roughness depends on the food particle shape and size. Food particles with at least two small dimensions such as rice, pack to form a relatively smooth surface. Food particles large in all three dimensions such as carrots tend to form surfaces with large depressions. A measure of surface roughness is the height from the bottom of a depression to the peaks. This measurement for some food types is given below.

	Height of Depression			
Food	Maximum Package		Average Maximum	
	m	(inch)	m	(inch)
Rice and Chicken	0.0032	(0.13)	0.0032	(0.13)
Chili with Beans	0.0040	(0.16)	0.0037	(0.15)
Beef and Rice	0.0044	(0.17)	0.0041	(0.16)
Corn	0.0064	(0.25)	0.0059	(0.23)
Beans and Franks	0.0071	(0.28)	0.0060	(0.24)
Carrots	0.0079	(0.31)	0.0071	(0.28)

6.2 Food Package Internal Air

In 90% of the food packages, the internal air pressure was less than 5330 N/m^2 (40mm Hg). The average pressure was about 3330 N/m^2 (25mm Hg) and one package was as low as 667 N/m^2 (5mm Hg).

The food packages were re-measured after a 5 week interval and showed no change in air pressure within the limits of error, 667 N/m^2 (5mm Hg).

6.3 Septum Leakage

6.3.1 Air

The leakage of air through the septum is small and for a septum as thin as 0.0032m (0.13 inch) would lead to a package pressure increase of only 133 N/m^2 (1 mm Hg). This is negligible compared to the average seal-off pressure.

6.3.2 Water

The range of septum thickness for the food packages was 0.005m (.19 inch) to 0.013m (0.5 inch). In no food package was any leakage of water observed. The packages were subjected to handling loads in excess of any that might normally occur during the meal preparation. To generate any significant pressure in the package, the palm of the hand was pressed hard over the surface to prevent distortion and pressure relief.

It was possible to get water leakage through the needle hole with the use of septum specimens in the pressurized leak test apparatus. With a gauge No. 15 needle a septum thickness of 0.006m (0.25 inch) was sufficient to prevent leakage with test pressure up to 41,400 N/m^2 (6 psig). At smaller thicknesses leakage occurs as a function of thickness. At the minimum package septum thickness a pressure of 6890-13,800 N/m^2 (1-2 psig) is required to force a drop of water through the septum. The required pressure is somewhat variable depending on the resistance to forces that tend to distort the septum and open up the puncture. This occurs with the specimen septum on a flat film which distorts to give a convex surface. In the package, with the septum located at the corner and restrained by the outer semi-rigid dish, distortion is more likely to improve the sealing ability. In the septum leakage apparatus, when the orientation of the septum is reversed (the septum material placed on the pressure side of the film) a septum which previously leaked at a given pressure, now was leak tight.

6.4 Needle Insertion and Withdrawal Forces

In most foods the food package resistance to needle penetration was relatively small and would present little problem to the user. The average insertion force was 20.9 N (4.7 pounds) with a maximum of 27.6 N (6.2 pounds). Withdrawal forces are lower and average 10.2 N (2.3 pounds).

For foods with high sugar content the food resistance increases. For applesauce the requirement was 37.8 N (8.5 pounds). This is still within the capability of the equipment and the user. However, a food package with large chunks of pineapple proved too difficult to penetrate at all. Once the high sugar foods are rehydrated the withdrawal forces are normal.

7.0 DISCUSSION

7.1 Septum Location

The package height must be great enough to allow the needle on insertion to pass between top and bottom surfaces without piercing the food wrapper. The packages studied had a minimum height of 0.023 m (0.9 inch) so that there was no difficulty in assuring adequate clearances. A minimum height should be set for any future packages that may not require as much filling. If the food package surface were uniformly smooth, this minimum height would be easily determined. However, the food package surface roughness requires some allowance. The greatest surface depressions measured were 0.0079m (0.31 inch) in carrots. Allowing for packaging thickness, the surface depression and a factor of safety. The minimum package height at the needle path would be about 0.019 m (0.75 inch) with the septum centered. This septum position is approximately that now used. It if were desirable to package smaller quantities, then the food particle size must be considered and there must be careful quality control of all packages.

7.2 Package Internal Air

The quantity of internal air was in most cases low enough so that its volume after rehydration at an atmosphere pressure did not interfere with rehydration. It was generally just visible as a small air bubble. The average seal-off pressure of about 3330 N/m^2 (25 mm Hg) is apparently satisfactory and should be easily attainable in routine package production.

The ability of the package to maintain its vacuum against film permeability or leakage will determine the product shelf life. There was no measurable pressure change after 37 days. It it is assumed that pressure build-up is proportional to the differential pressure across the package, and further that in the 37 days leakage was equal to the minimum detectable change, 667 N/m^2 (5 mm Hg), then an estimate of the maximum pressure at some future time may be made. A package originally at 3330 N/M^2 (25mm Hg) would not exceed the following pressure at the stated time.

Time	Pressure	
days	N/m^2	(mm Hg)
0	3330	(25)
180	6530	(49)
365	9730	(73)
730	15730	(118)

A shelf life of at least 6 months is probably safely predictable on the basis of this short term test. To predict a longer shelf life a longer term measurement must be made to more accurately determine the rate of pressure change.

7.3 Package Leakage

Air or water leakage through the septum does not appear to be very likely. However, the package/rehydration device interface must prevent a package misalignment where a corner without septum material is penetrated. If only the film is penetrated, the package could probably be reasonably well filled with water since air leakage with the needle in place and a constantly decreasing differential pressure would not be great. However, on needle withdrawal there would be some water leakage.

7.4 Needle Insertion Forces

Those foods, such as fruits, which create high resistance forces to needle penetration must be modified in some way or discarded. It may be possible to subdivide large chunks to bring the required forces to an acceptable range.

7.5 Quality of Rehydration

The rehydrated food was generally fairly uniform. Following a 20 minute holding time for flavor development, there were few dry spots. Occasionally the interior of a bean was not fully rehydrated. This might be corrected by a slightly higher food temperature or longer holding time. In some foods, which require a large quantity of water, free water formed at the surface when the water is first added. After the holding period this free water is mostly absorbed by the food. A slight stirring of the food on opening the package results in a completely uniform product. An initial flow rate of .454 kg/min. (1 pound/min.) was cut in half to help absorb the water at the rate it is dispensed. This resulted in some improvement.

When food prepared with the Shuttle system was compared to the identical food prepared more conventionally by adding boiling water and stirring in an open saucepan, the former was always at least as good as the latter. There were some obvious physical differences as in the case of rice where the grains appeared fluffier in the vacuum rehydrated case. The grains are presumably more fully rehydrated since the water did not have to displace air within the grain. In both cases the food was more acceptable if the temperature was not allowed to drop below about 60°C (140°F). For food rehydrated with 71°C (160°F) water, some active heating during the holding time is desirable.

8.0 DRINK DEVICE

8.1 Objective

In addition to food rehydration, the needle probe/septum concept must be compatible with a drink device. No new drink device has been developed. Part of the current program is devoted to the consideration of possible modifications of the Skylab bellows type drink device for use with the needle probe. Ideally, the modification would not require major rework. The drink cup would be used for rehydratable beverages and for drinking water. Therefore, a capability for reuse must be inherent in the design. The design must be evaluated for feasibility and utility with respect to the galley filling and dispensing system. The existing drink nozzle is to be used without change.

8.2 Approach

Two distinct design approaches were studied:

(a) Modification of the existing Skylab bellows cup to accept a septum and rehydrate through the septum using the galley probe.

(b) Utilization of the Skylab bellows cup as is, with no modification, and adapt the galley probe to mate with the cup.

8.2.1 Drink Cup With Septum

Two possibilities were considered for location of the septum:

(a) Option 1, Base Mounted Septum (Figure 3). This option utilizes the existing drink cup and incorporates a base mounted septum for rehydration. The septum material is dispensed on a supporting ring to which it adheres. The supporting ring has a pre-drilled hole to permit clear passage of the probe. The base of the Skylab package may also be drilled with a mating hole so that on bonding the ring to the package base, the holes are aligned at the package centerline but are completely sealed by the septum material.

(b) Option 2, Side Mounted Septum (Figure 4). The molded wall directly below the valve flange provides a semi-rigid diameter on which a small septum could be located.

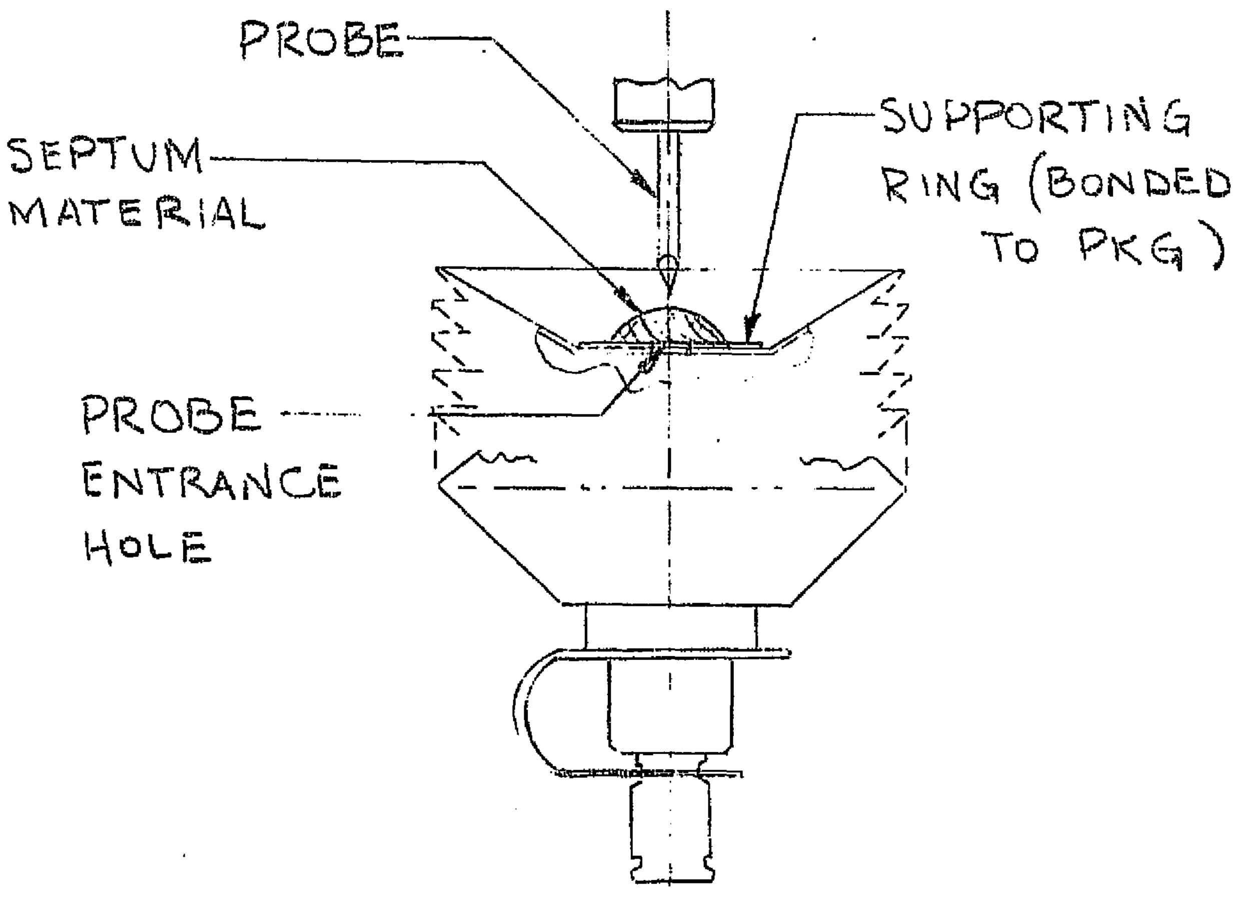


Figure 3. Base Mounted Septum

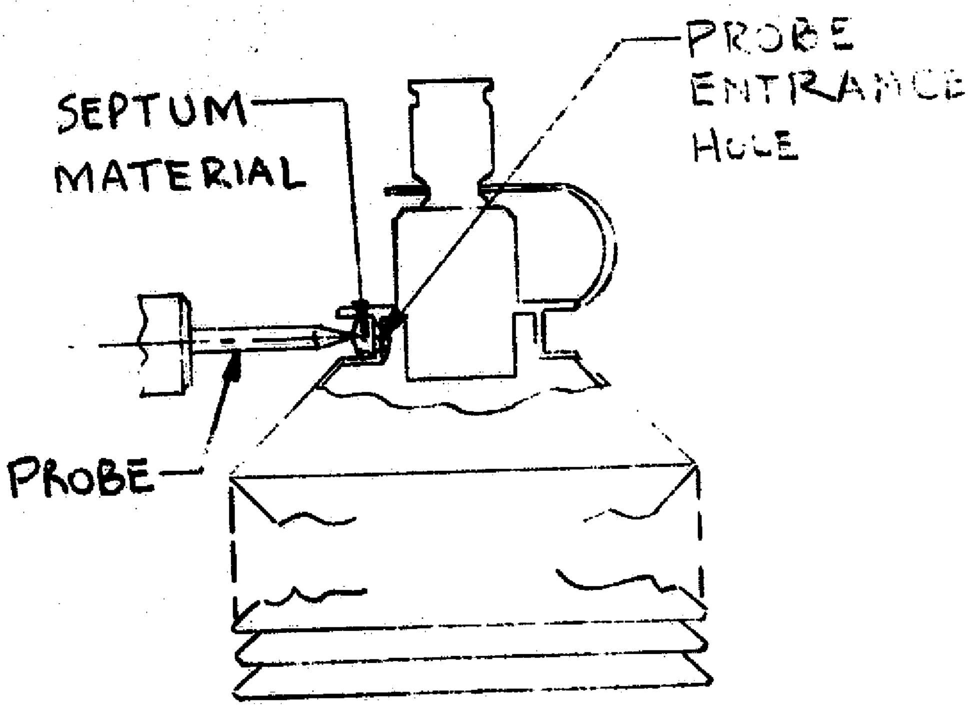


Figure 4. Side Mounted Septum

8.2.2 Needle Probe Modification

Two possibilities were considered in which the drink cup remains unchanged.

(a) Option 1, Interchangeable Probes. The water system can be designed to accept both the needle probe for food rehydration, or the same probe used originally with the Skylab drink cup.

(b) Option 2, Common Probe (Figure 5). The probe assembly may possibly be designed to interface both with the food package septum and the standard Skylab valve.

8.3 Evaluation

8.3.1 Drink Cup With Septum

The modification to incorporate a septum in the base of the cup is relatively simple to accomplish. In practice it suffers from two drawbacks. When the drink cup is evacuated, the normal storage state, the bellows cup collapses to an irregular shape that presents a problem for the automatic alignment of the septum with the needle. A modification shown in Figure 6 might circumvent this problem. However, a further problem is that in the evacuated cup the base is in close proximity with the valve. When the needle probe is inserted sufficiently for the needle apertures to clear the septum, it intercepts the valve.

The side mounted septum is again a modification that retains the Skylab cup essentially intact and is not affected by evacuating the cup. However, it too suffers from insufficient clearance. For this scheme to work, the needle aperture would have to be located on the needle axis in the same fashion as a standard hyperdermic needle. However, in studies with the Shuttle water system (RD008V3201) it was concluded that the most suitable configuration would be radial apertures which avoid the problem of cutting cores that could clog the needle. In such a needle, the apertures are behind the point instead of being essentially at the point.

8.3.2 Probe Modification

This approach has the advantage of not requiring any drink cup modification. The use of interchangeable probes is not considered desirable since it requires an additional operation by the user. Also, it may either require a more complex probe assembly or necessitate handling loose parts.

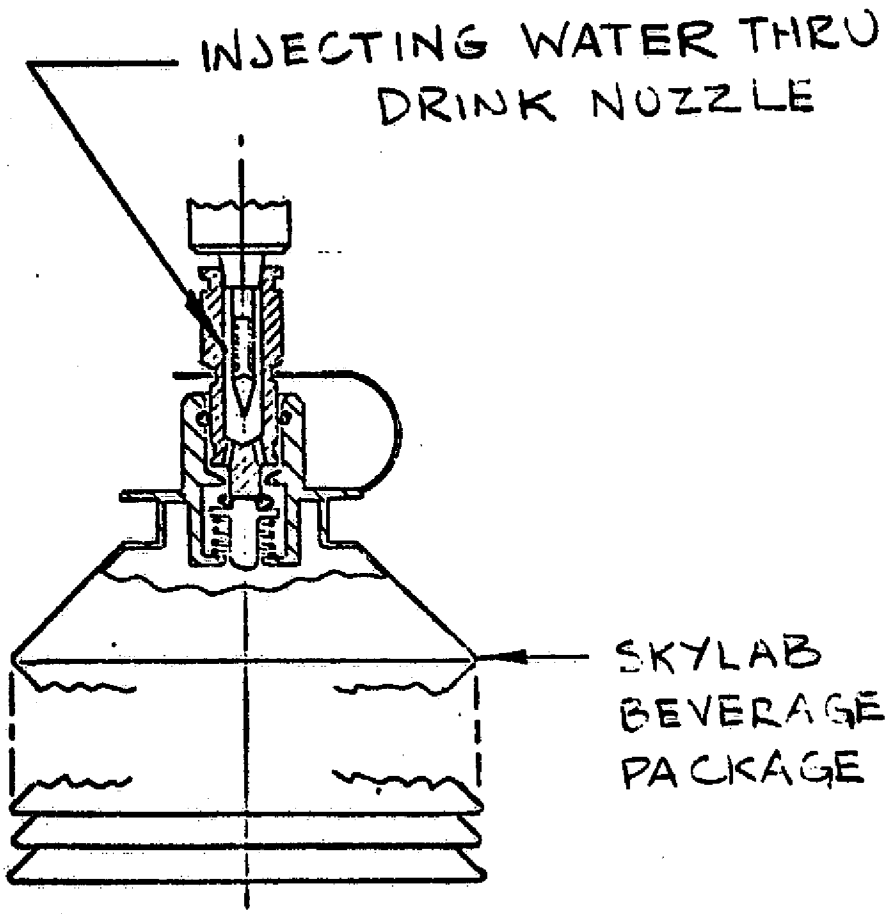


Figure 5. Skylab Drink Cup with Modified Needle Probe

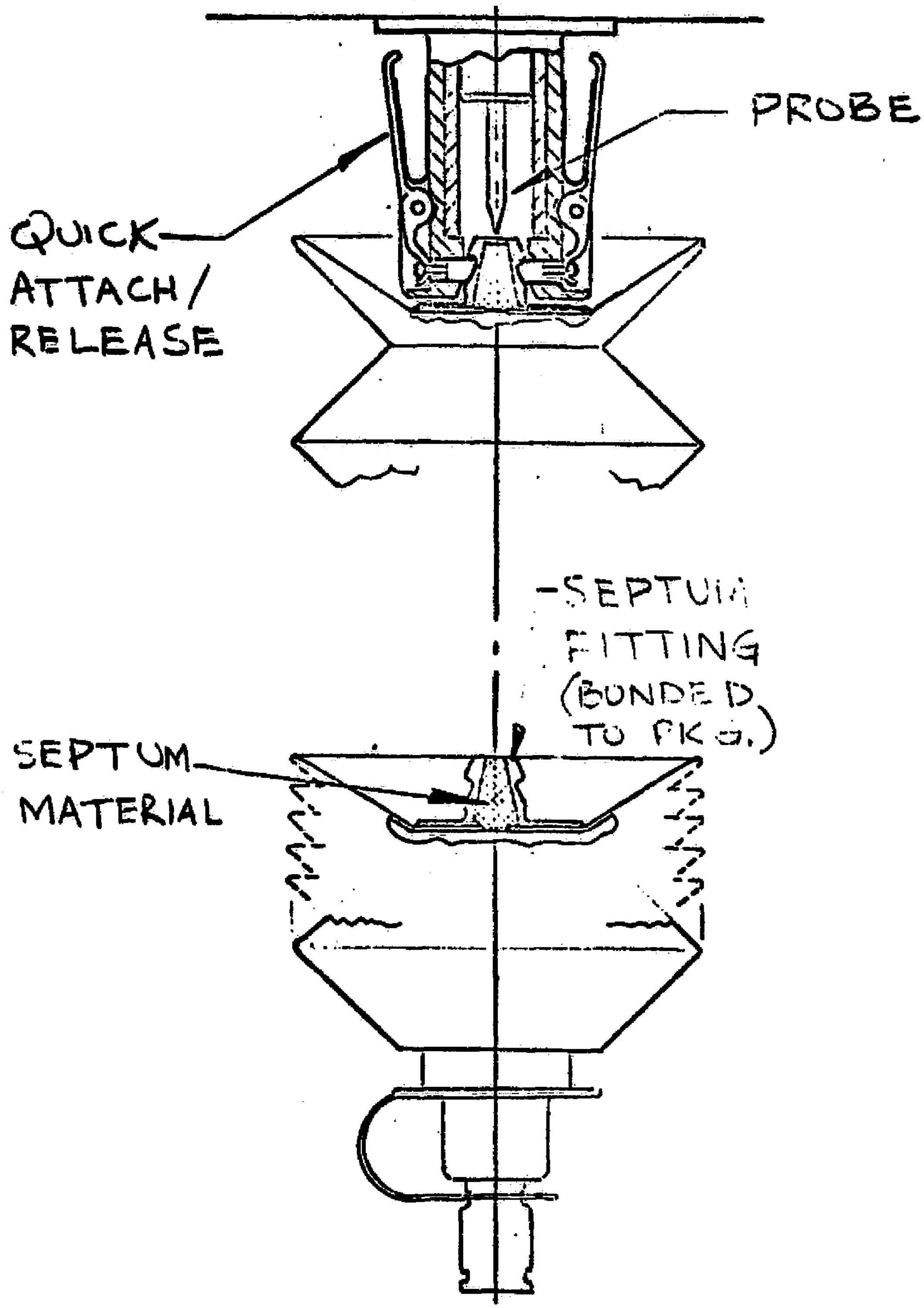


Figure 6. Positive Gripping of Base Mounted Septum

Modification of the probe to serve both the food package and the drink cup would be the best solution if it is feasible. The modification involves the addition of a shoulder on the needle which engages the valve body before the needle point bottoms on the valve. The shoulder forms a seal to prevent loss of fluid or entry of air. The shoulder then pushes the spring mechanism opening the valve. Filling is now the reverse of drinking. The success of this approach depends on the needle being short enough to prevent bottoming, and long enough to satisfy the food package requirement that the needle length behind the aperture be at least equal to the thickness of the largest food package septum.

Food package septa are of variable thickness because of the very simplicity of package fabrication. They may vary from 0.005m (0.19 inch) to approximately 0.013m (0.5 inch). The apertures and point may add as much as .009 m (0.35 inch). The needle length to the shoulder must then be at least 0.022 m (0.85 inch). The available depth in the drink valve is .023m (0.90 inch). This is marginally acceptable since the shoulder will take some space. However, the needle point can be reduced somewhat and control of septum maximum thickness should make it possible to provide an adequate safety margin. A possible configuration for a common food package and drink device holder is shown in Figure 7.

8.4 Alternate Approach

Debriefing of the Skylab crews revealed some problems with the drink device. The drink valve, since it is an expendable item with each cup and consequently mass produced, did not always seal well and admitted air to the cup which was subsequently ingested by the user. The bellows portion of the cup could be retained and the current two part valve assembly replaced with a septum sealing the opening and a reusable drink valve with needle probe. The drink valve would require some development.

An additional problem was the lack of cup insulation which caused hot drinks to cool down too quickly. An insulated, reusable outer container would solve this problem.

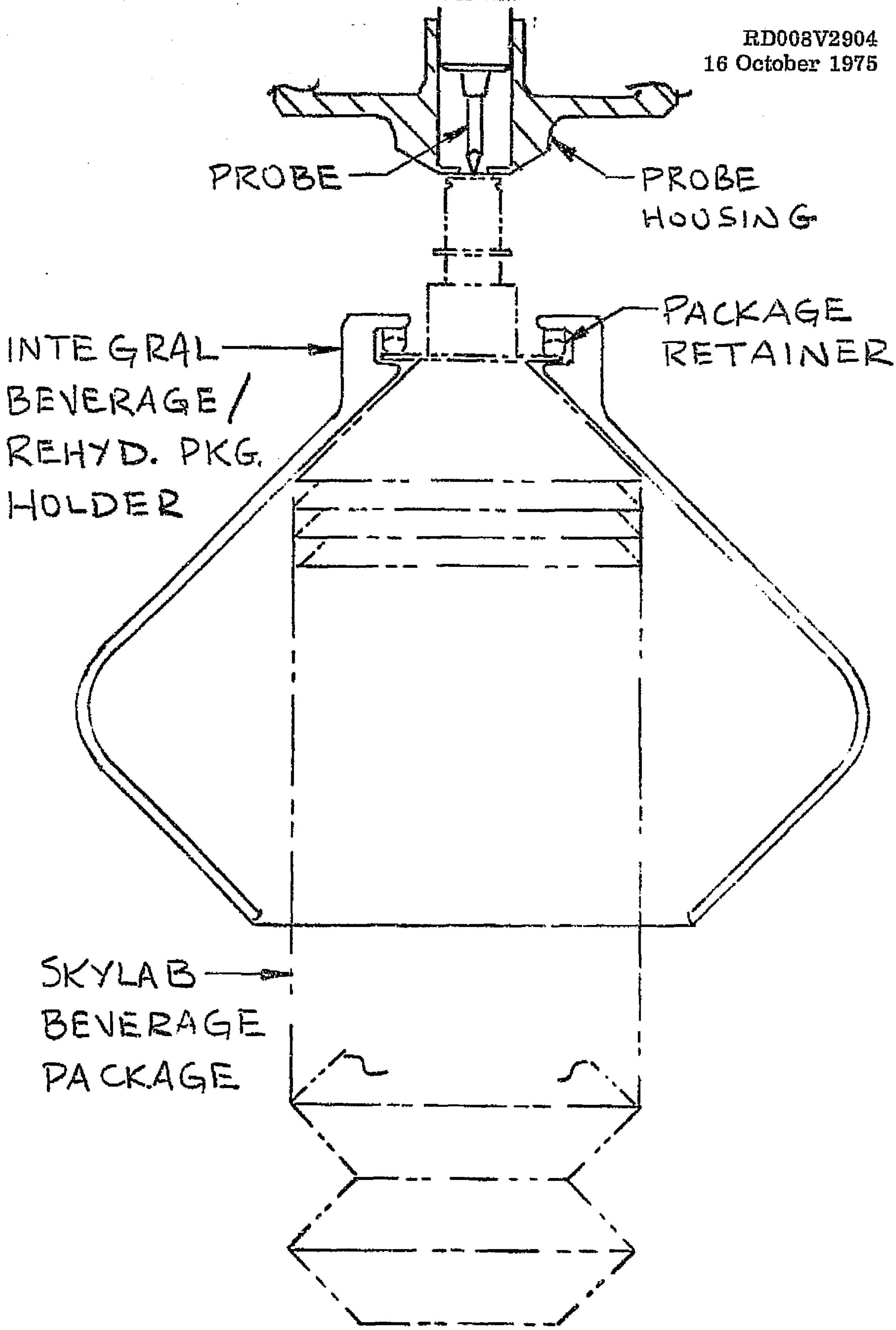


Figure 7. Holder for Food Package and Skylab Drink Cup

9.0 REDOMMENDATION

The rehydratable food package as currently configured is essentially suitable to the Shuttle mission. It is light weight, simple to rehydrate, and leakproof. The attained seal-off pressure of 3300 N/m^2 (25m Hg) is adequate, but can probably be extended downward by a factor of ten. While this is perhaps not necessary from the viewpoint of good rehydration, it would extend the shelf life of the food. Shelf life could not be determined because of the shortness of the test period. The only prediction is that shelf life is at least six months. Longer test intervals should be established to predict shelf life.

The Skylab drink cup could be used as is with proper design of the needle probe assembly. This approach may require some tighter control of food package production to limit septum thickness. Development of a new reusable drink valve together with the Skylab cup modified with a septum may be a better solution. The new reusable valve could be engineered to be leak proof and easier to use thus eliminating the problems encountered on Skylab.

The design of the food package and septum, and drink device is so closely related and interdependent on the interface with the water system probe, it is recommended that the galley designer and the food package designer maintain a continuing interchange of data to assure mutual compatibility.

DESIGN SELECTION

- Conceptual Designs
  - Concept #1
    - Add Retention Strap to Package Bottom
    - Modify Tray to Add Hinged Door
    - Add Retention Lips to Tray
    - Rehydrate in Tray

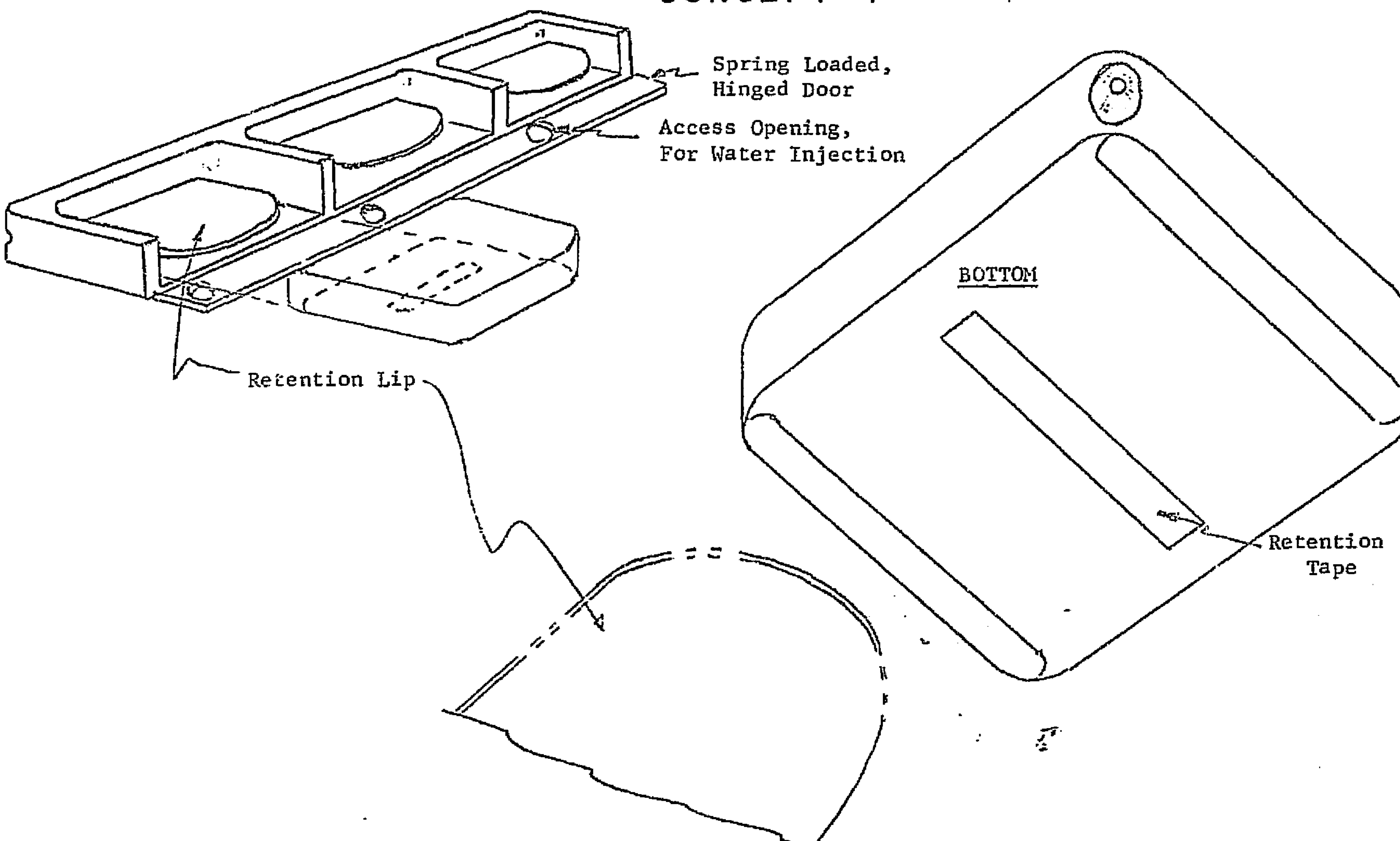
Pillsbury

SPACE SHUTTLE FOOD SYSTEM STUDY

Contract: NAS 9-13138
Chart No: 11
Date: 6/25/75

DESIGN SELECTION

- CONCEPT 1

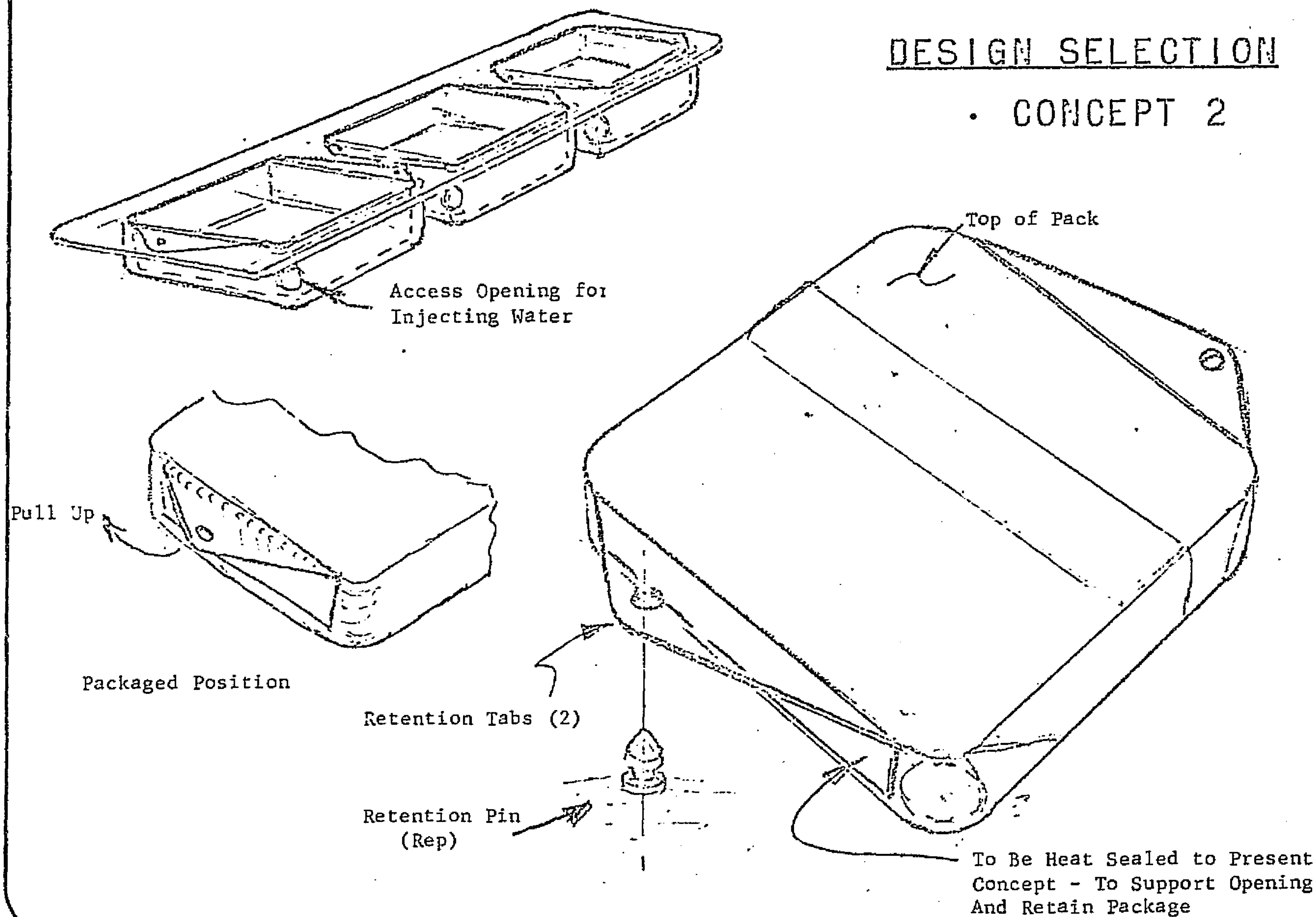


DESIGN SELECTION

- Conceptual Designs
  - Concept #2
    - Add Tabs With Punched Holes to Package Sides
    - Add Retention Pins to Tray
    - Rehydrate in Tray

DESIGN SELECTION

• CONCEPT 2

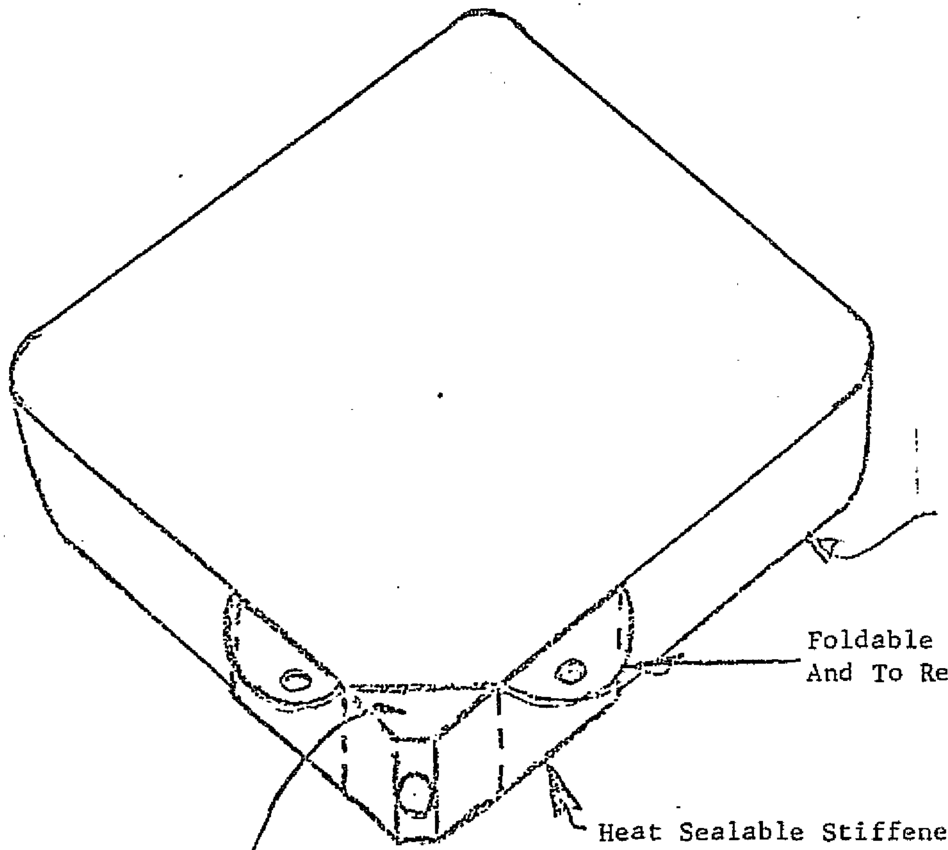


DESIGN SELECTION

- Conceptual Designs
  - Concept #3
    - Add a Rigid Base Segment to Package for Attachment to Water Dispenser & Tray Insert
    - Add Retention Pins in Tray
    - Rehydrate in Tray

DESIGN SELECTION

- CONCEPT 3

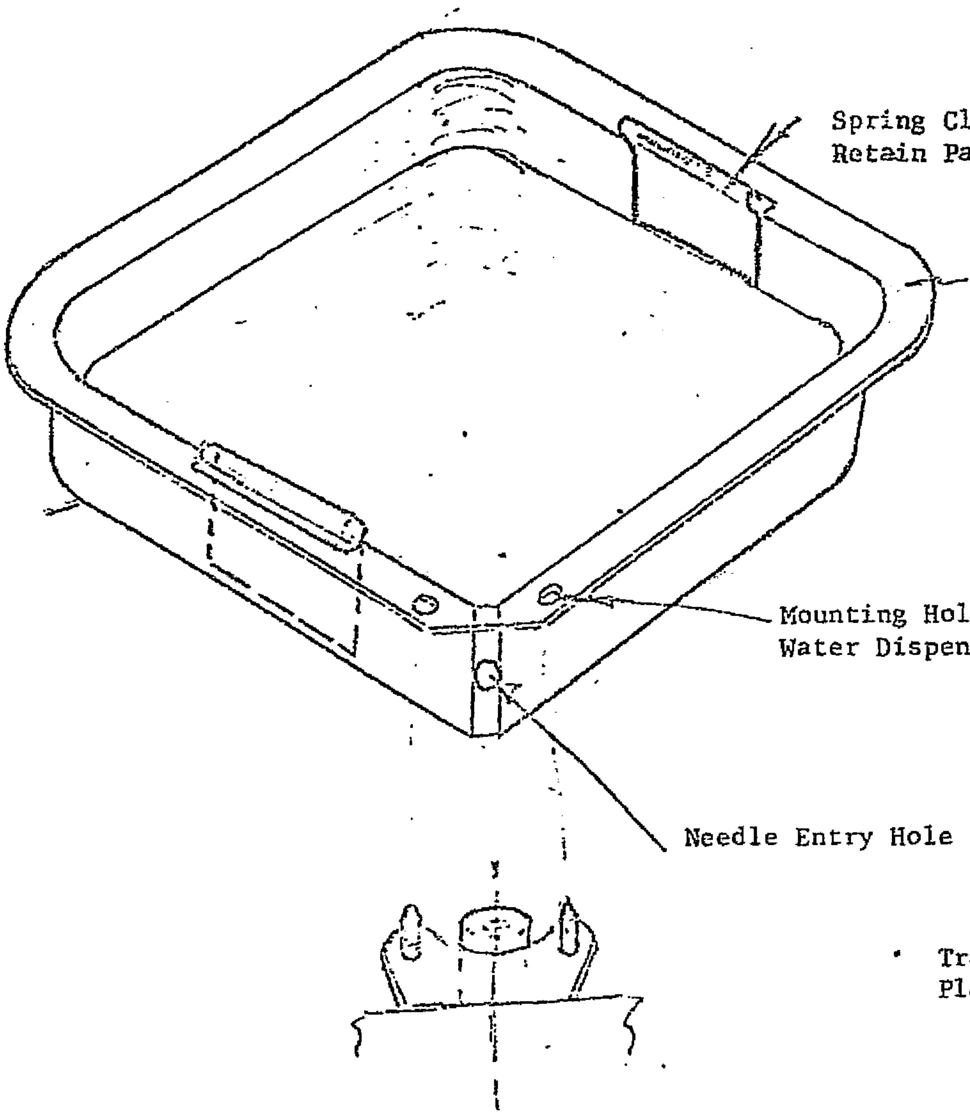


DESIGN SELECTION

- Conceptual Designs
  - Concept #4
    - Use 21 Re-Usable Bases for Package Rather Than 308 Package Bases
    - Modify Tray Insert to Flat Plate to Accept Re-Usuable Base
    - Rehydrate in Tray

DESIGN SELECTION

- CONCEPT 4



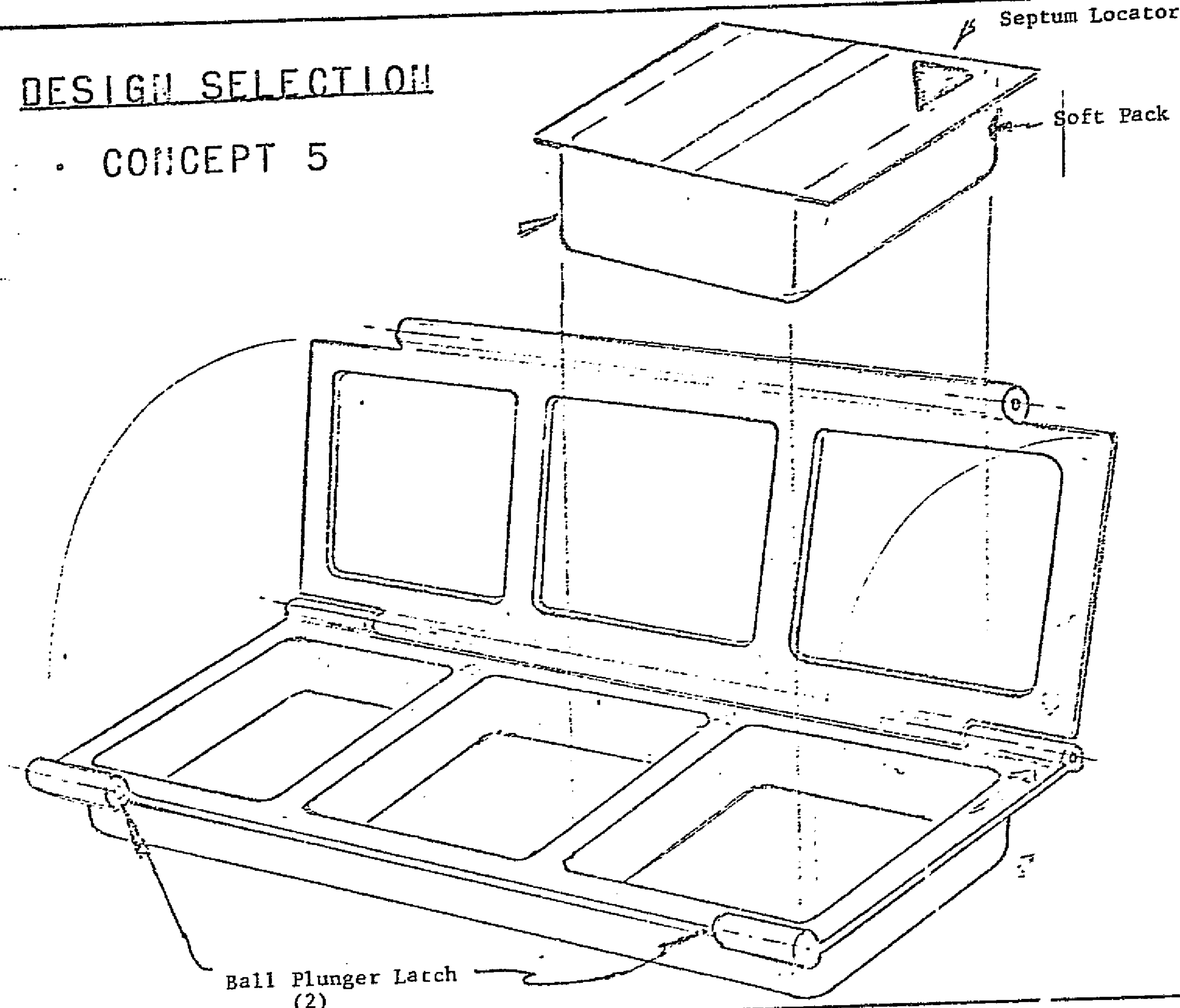
- Tray Insert Need Only Be Flat Plate With 3 Square Holes

DESIGN SELECTION

- Conceptual Designs
  - Concept #5
    - Use Soft Package As Is
    - Redesign Tray to Provide All Interface Functions
    - Rehydrate in Tray

DESIGN SELECTION

- CONCEPT 5

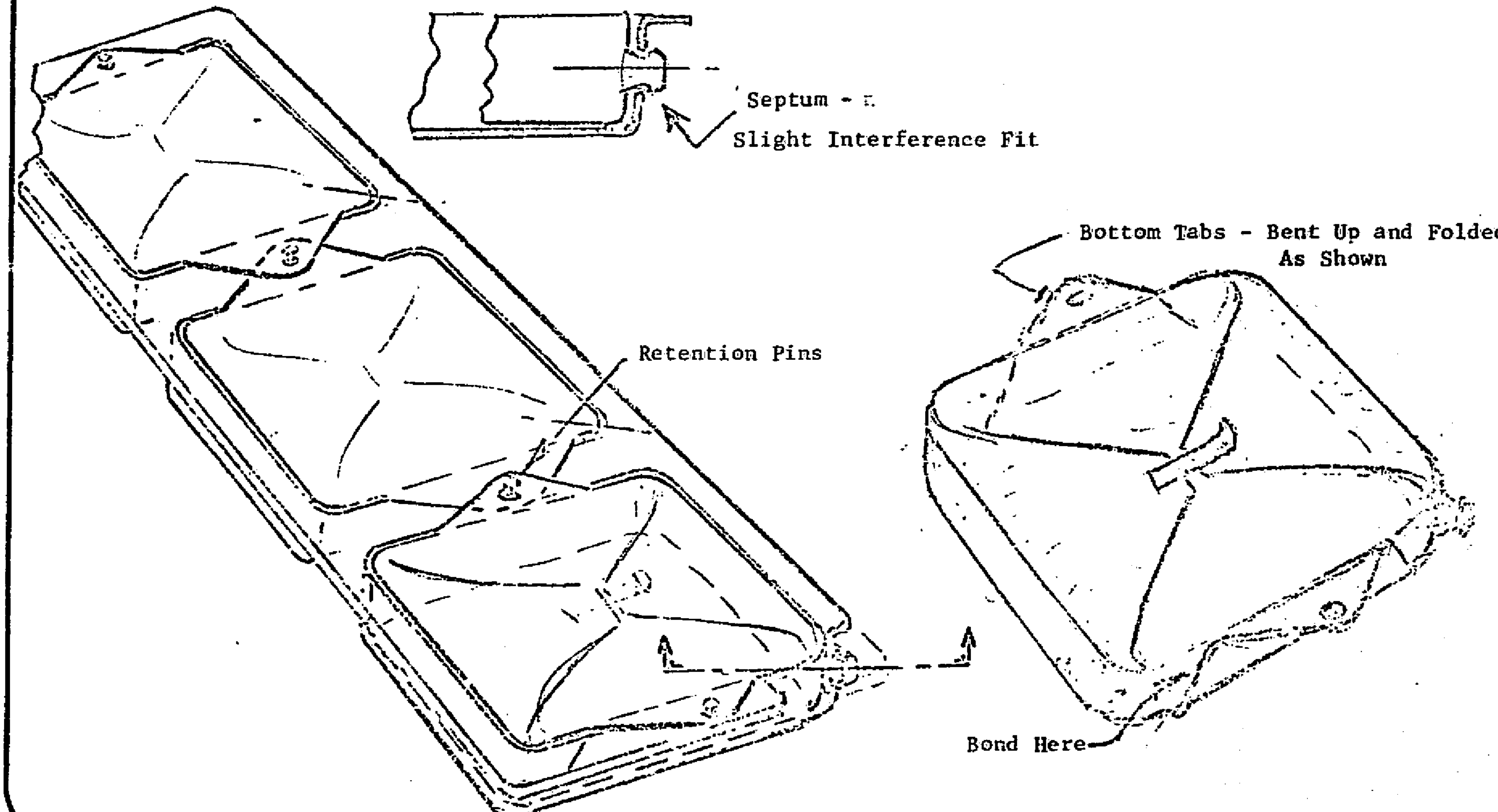


DESIGN SELECTION

- Conceptual Designs
  - Concept #6
    - Reform Package and Heat Seal or Bond Two Lower Tabs to Package Sides as In Concept #2
    - Pierce Retaining Holes in Tabs
    - Apply Septum Material to a Side Fitting on Package
    - Add Retaining Pins to Tray
    - Rehydrate in Tray

DESIGN SELECTION

• CONCEPT 6

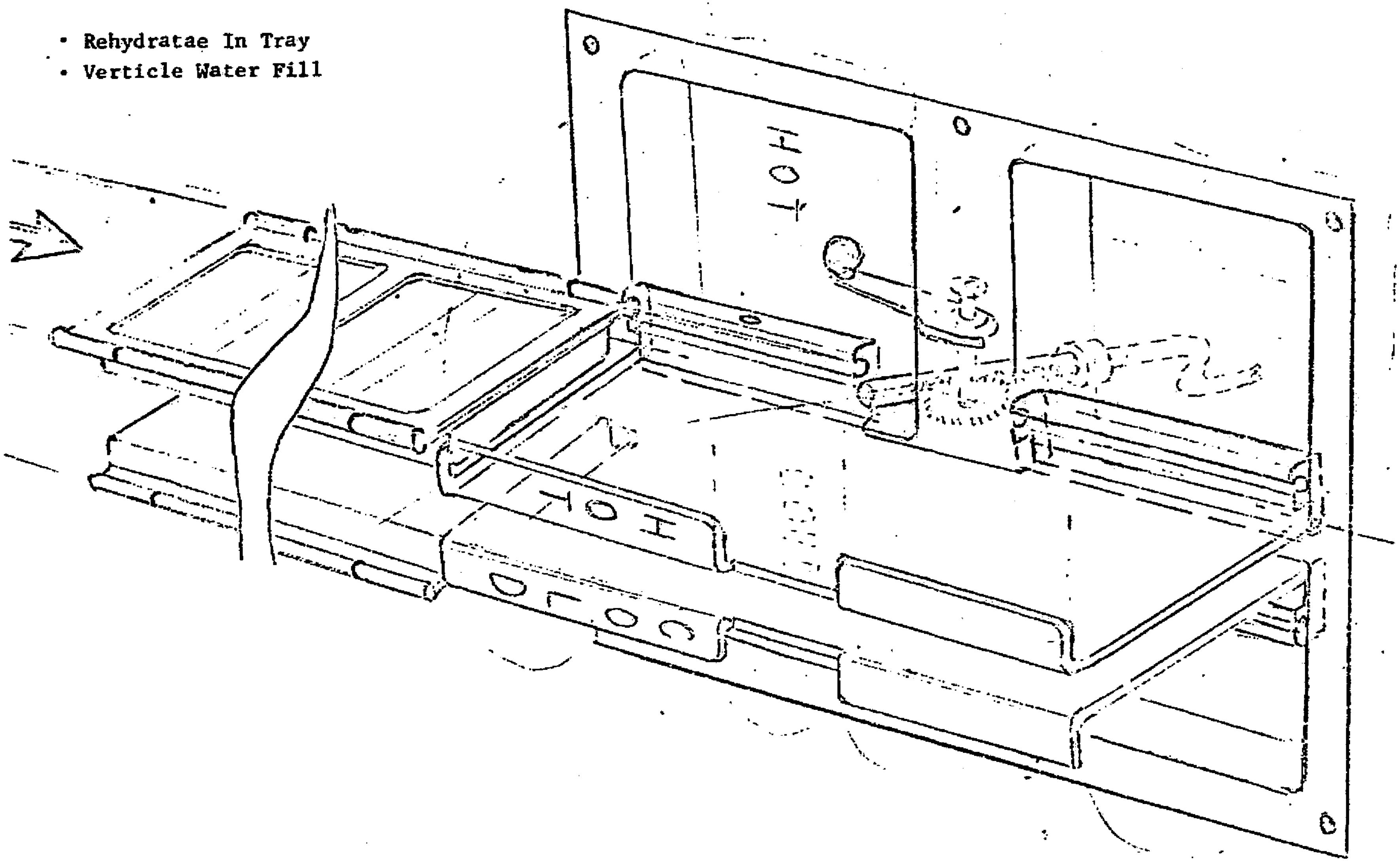


DESIGN SELECTION

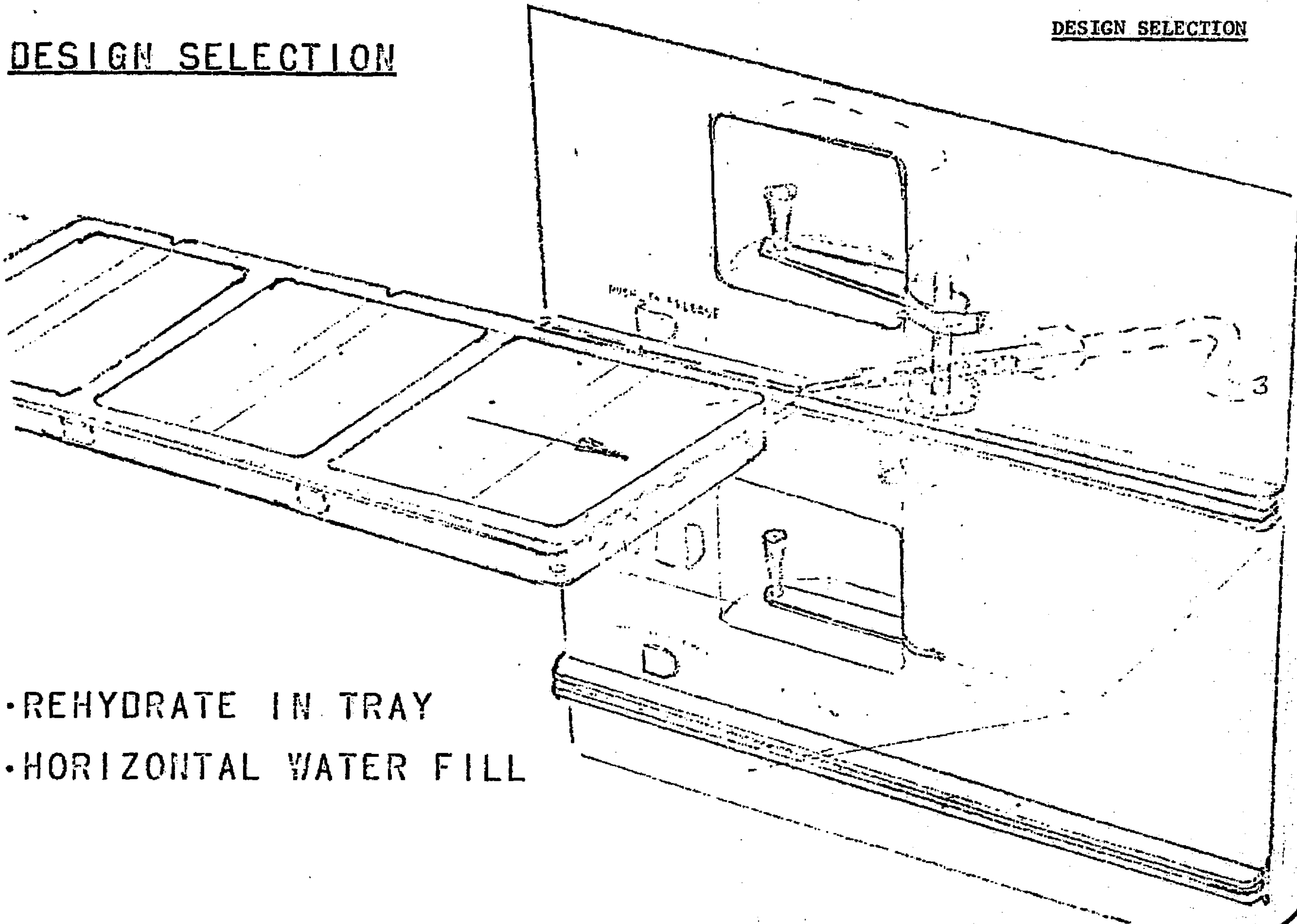
- Water System Interfaces
  - Rehydrate in Tray
    - Locate and Position Tray to Water System
    - Orientation and Indexing to Probe
    - Angular Insertion of Probe

DESIGN SELECTION

- Rehydratae In Tray
- Verticle Water Fill



DESIGN SELECTION



- REHYDRATE IN TRAY
- HORIZONTAL WATER FILL

Pillsbury

SPACE SHUTTLE FOOD SYSTEM STUDY

Contract: NAS 9-13138
Chart No: 26
Date: 6/25/75

DESIGN SELECTION

- Weight Analysis

Concept	Packages (308)			Trays (7)	Concept Δ Weight
	Rigid Base	Mod	NET		
1	-9.2	+0.1	-9.1	+1.00	-8.1
2	-9.2	+0.7	-8.5	+0.3	-8.2
3	-9.2	+0.4	-8.8	+0.3	-8.5
4	-9.2	-	-9.2	+0.7	-8.5
5	-9.2	+0.4	-8.8	+3.5	-5.3
6	-9.2	+0.4	-8.8	+0.3	-8.5

DESIGN SELECTION

- Conclusions/Recommendations
  - Rigid Base Selected
    - Weight Penalty Not Significant for Expected Advantages
    - Trash Volume is Recycled so Savings are Primarily Day 1 Trash Volume
    - Greater Growth Potential Since Use of Package not Dependent on Tray as in Other Concepts
    - Acceptability and Easier Handling Characteristics
    - No Significant Costs or Fabrication Penalties

DESIGN SELECTION

- Conclusions/Recommendations
  - Of Six Concepts Considered - Concept #6 Preferred for Trade-Off with Rigid Base

Rigid Base	Concept #6
• Package Protection	• Less Weight
• Control of Septum Location	• Less Trash Volume
• Septum Protection	• Fewer Package Parts
• Individual Rehydration Capability orin Tray	
• Flexibility in Use	
• Ease of Handling	

PACKAGING MATERIAL SPECIFICATION (PMS)

NAME: Rigid Base

CODE	ISSUE	DATE
100		
SUPERSEDES		PAGE 1

DIMENSIONS: ______ CONDITIONS OF USE: ______

FOOD TYPE : ______

CLASS : ______ GEN SPEC ______

ITEM	CHARACTERISTIC	TP NO	STANDARD	TOLERENCE	ACTION

INTRODUCTION:

The intended use of the tray will not bring it into direct contact with food but is a component of a total food package. Therefore, all forming materials, mold release spray, etc., used in the manufacturing process of this product must be nontoxic and nonflammable.

DESIGN: As per drawing on Page 3.

Internal Dimensions		
Length	4	± 1/32
Width	4	± 1/32
Height	7/8	± 1/32

MATERIAL: Rigid Poly Vinyl Chloride

Thickness (before forming) 35 mil ± 3.5 mil
Finish - matt both sides
Color - white opaque

AGENTS:

For the modification of any characteristic such as static, friction, flexibility shall not be used unless herein specified. This includes agents used to improve production rates, such as mold release sprays, etc.

Objectionable Odors shall not be carried or imparted by finished trays.

Sanitation - Trays shall be free of scrap, lint, dirt, grease, etc. Any evidence of filth, rodent and insect infestation or the like shall be grounds for

SHIPPING AND STORAGE DIRECTIONS: ______

APPROVALS ______

NAME: Rigid Base

CODE	ISSUE	DATE
100		
SUPERSEDES		PAGE
		2

DIMENSIONS:

CONDITIONS OF USE:

FOOD TYPE :

CLASS :

GEN SPEC

ITEM	CHARACTERISTIC	TP NO	STANDARD	ACTION	TOLERENCE

rejecting entire lot so contaminated.

Die Cutting - die cut edges shall be clean and free of sharp edges that may be injurious to users.

Printing - None.

SHIPPING AND STORAGE DIRECTIONS:

APPROVALS

THE PILLSBURY COMPANY

PACKAGING MATERIAL SPECIFICATION (PMS)

NAME: H-bottom Pouch

CODE	ISSUE	DATE
	200	
SUPERSEDES		PAGE

DIMENSIONS:

CLASS :

CONDITIONS OF USE:

FOOD TYPE :

GEN SPEC

ITEM	CHARACTERISTIC	TP-NO	STANDARD	TOLERENCE / ACTION

INTRODUCTION:

The intended use will bring the inside surface of this material into direct contact with food in a vacuum pack and the supplier must comply with the "General Conditions" found on back.

DESIGN:

As per drawing on Page 2, 3, 4.

Style - Flat "H" type bottom, premade pouch with fins.

The bag must conform to the following:

a) Side and bottom seals - 1/4" heat seals ± 1/16 tolerance
b) Bottom ear fins must be completely heat sealed

Size: As specified on Drawings

MATERIAL:

Structure - materials are listed from outside to inside.

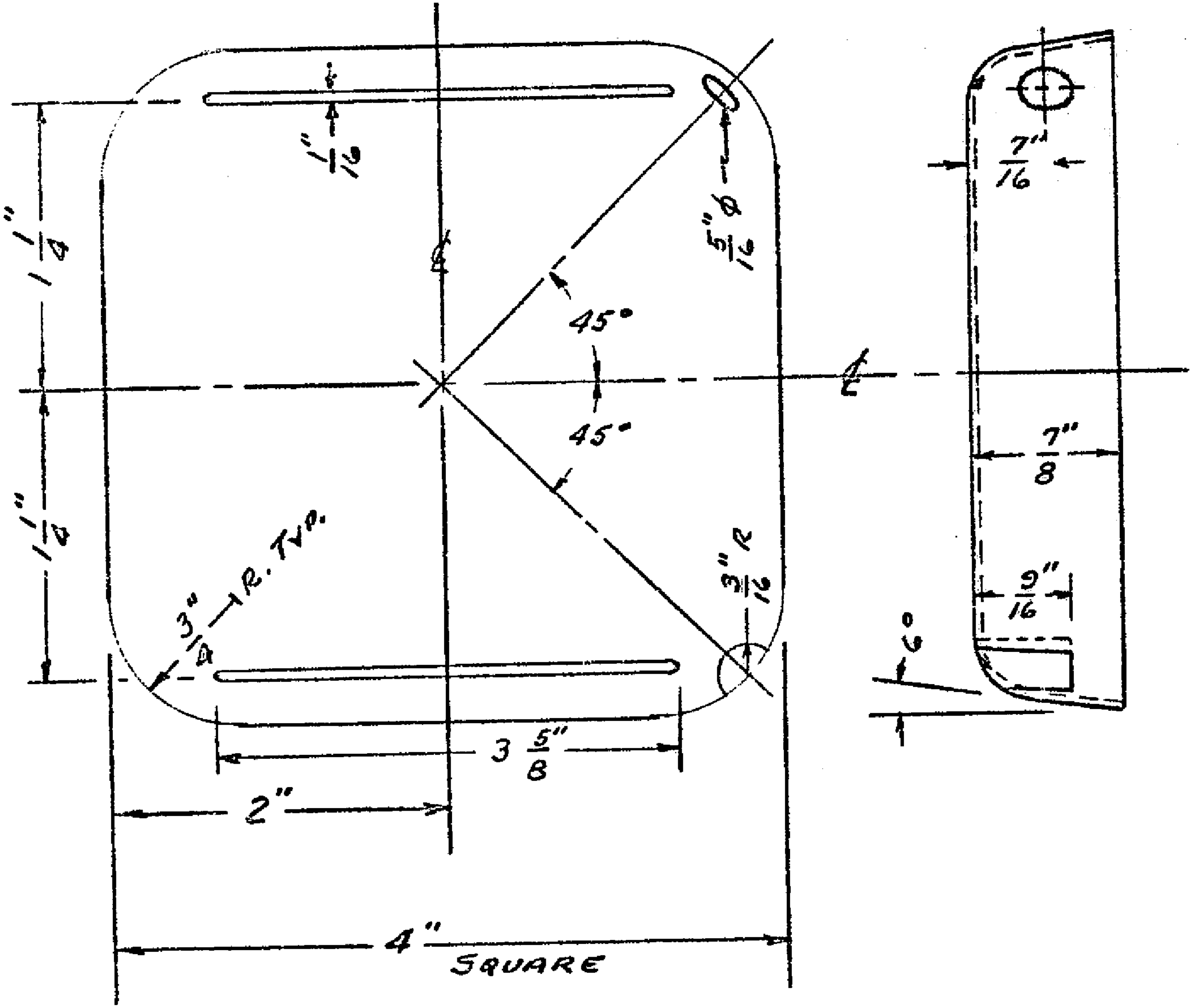
Characteristic	TP-NO	Standard	Tolerence
Nylon coated 1 side with Saran laminated with		25.0 lbs.	± 10%
Thermosetting adhesive to		1.4 lbs.	± 10%
Surlyn		44.0 lbs.	± 10%
Total Basis weight/3000 sq.ft.	90.008	70.4 lbs.	± 7.04 lbs.
WVTR	90.007	0.5 grams	Maximum
O_2 Rate		0.99 cc/100 sq.in. 24 hrs/at 72°F	Maximum

Agents for the modification of any characteristics such as static, friction, flexibility, etc., shall not be used unless specified herein.

Objectionable Odors - shall not be carried or imparted by the finished material.

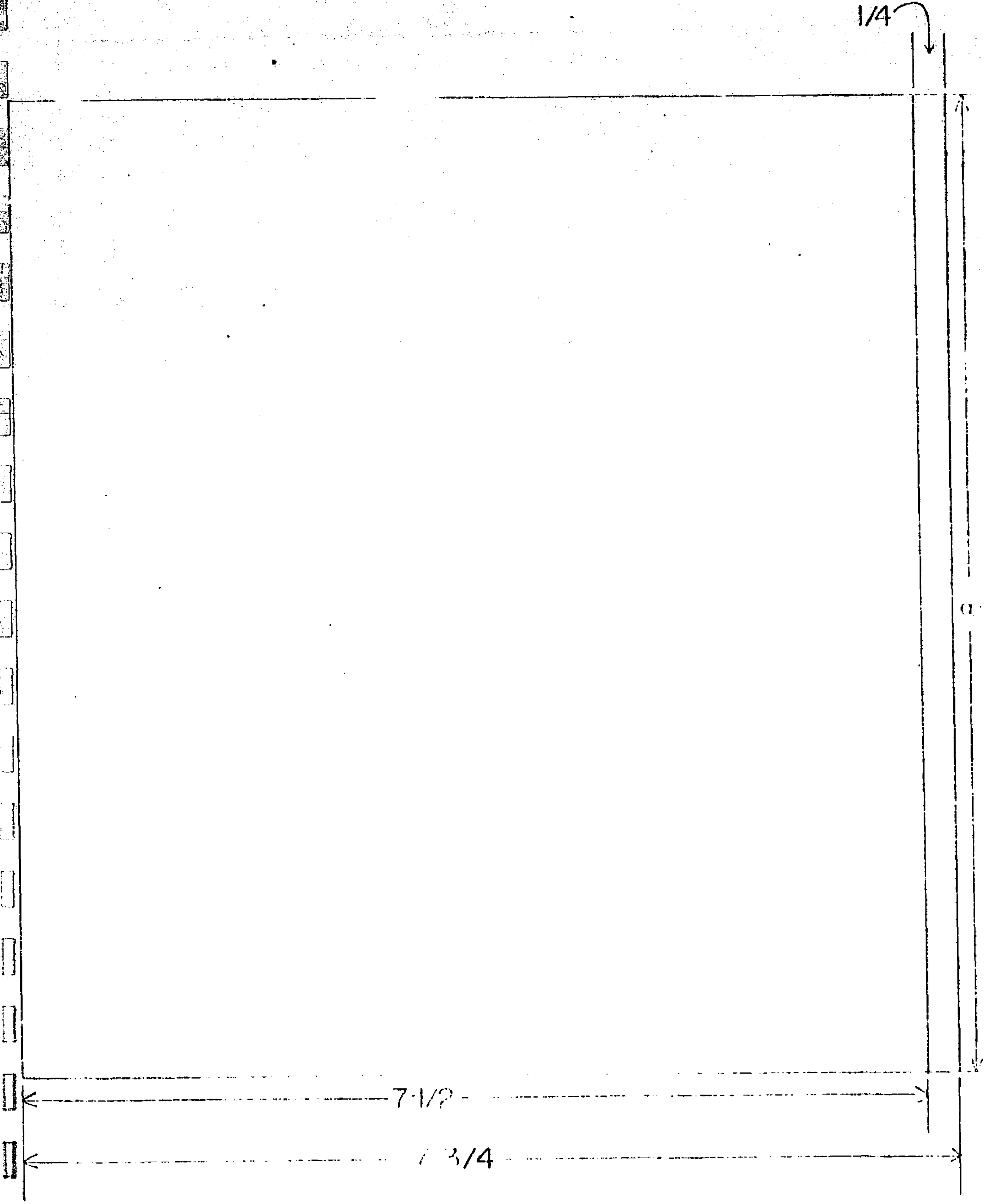
Printing - None.

APPROVALS

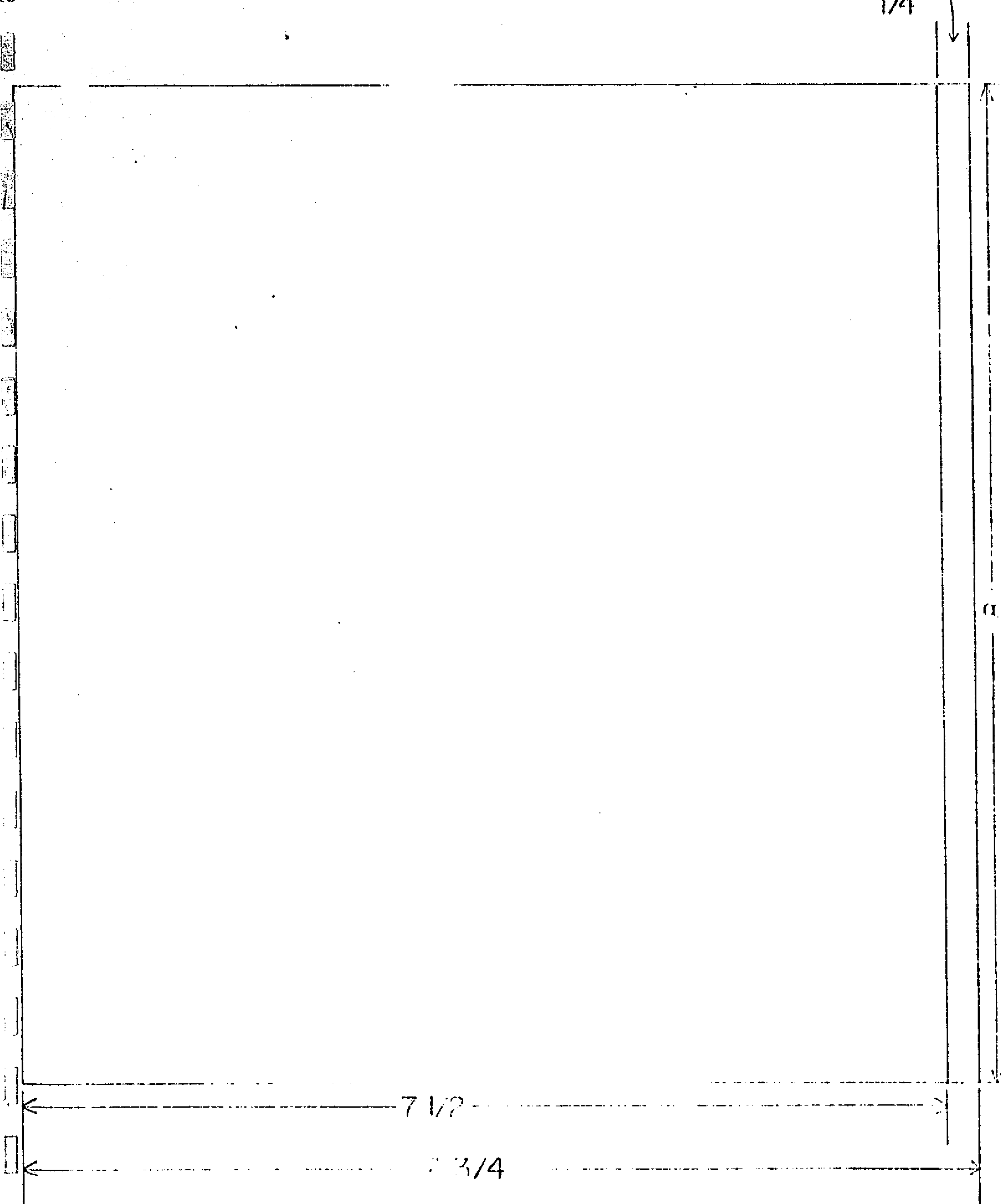


NOT TO SCALE

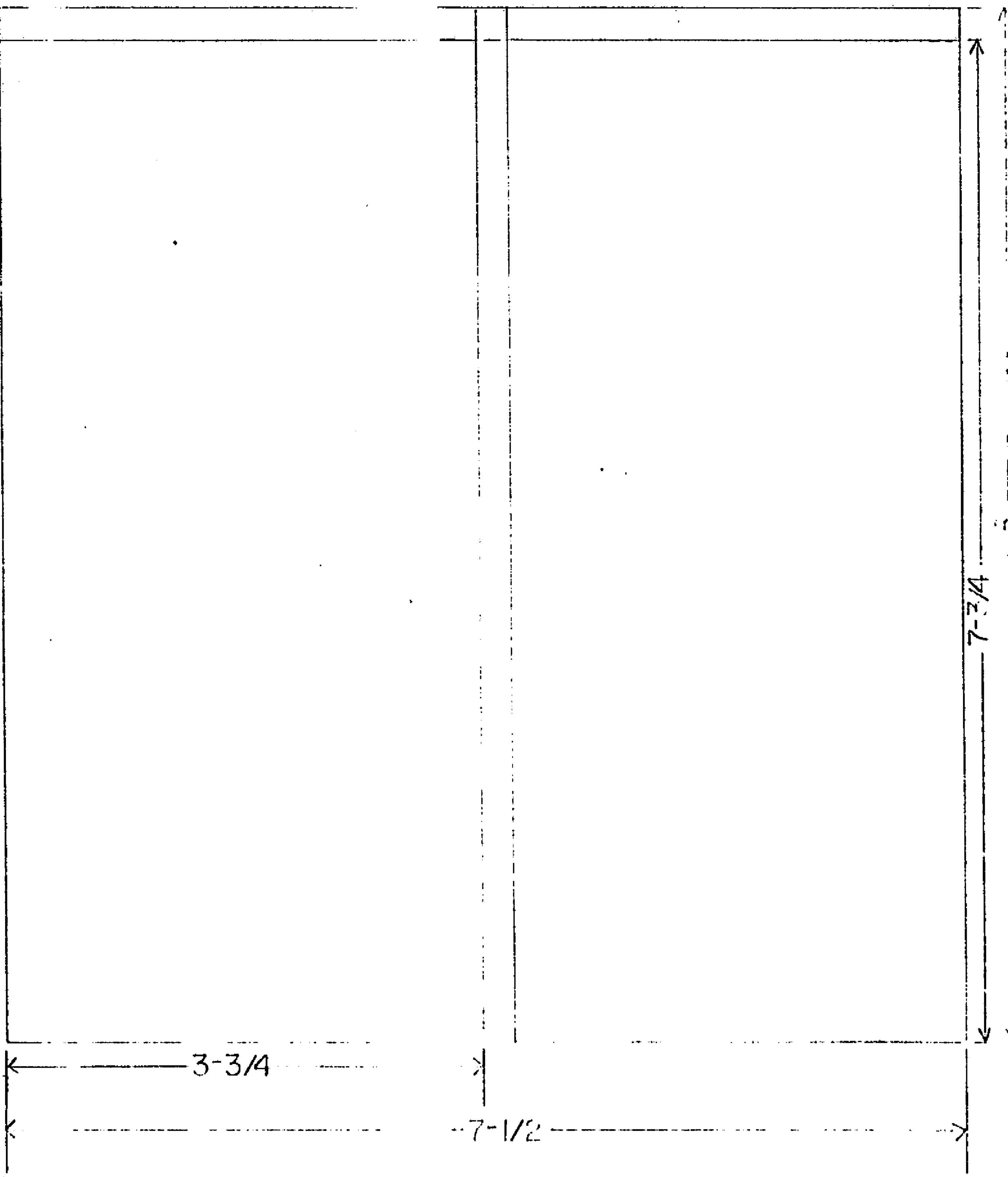
DWG. NO. 100-3



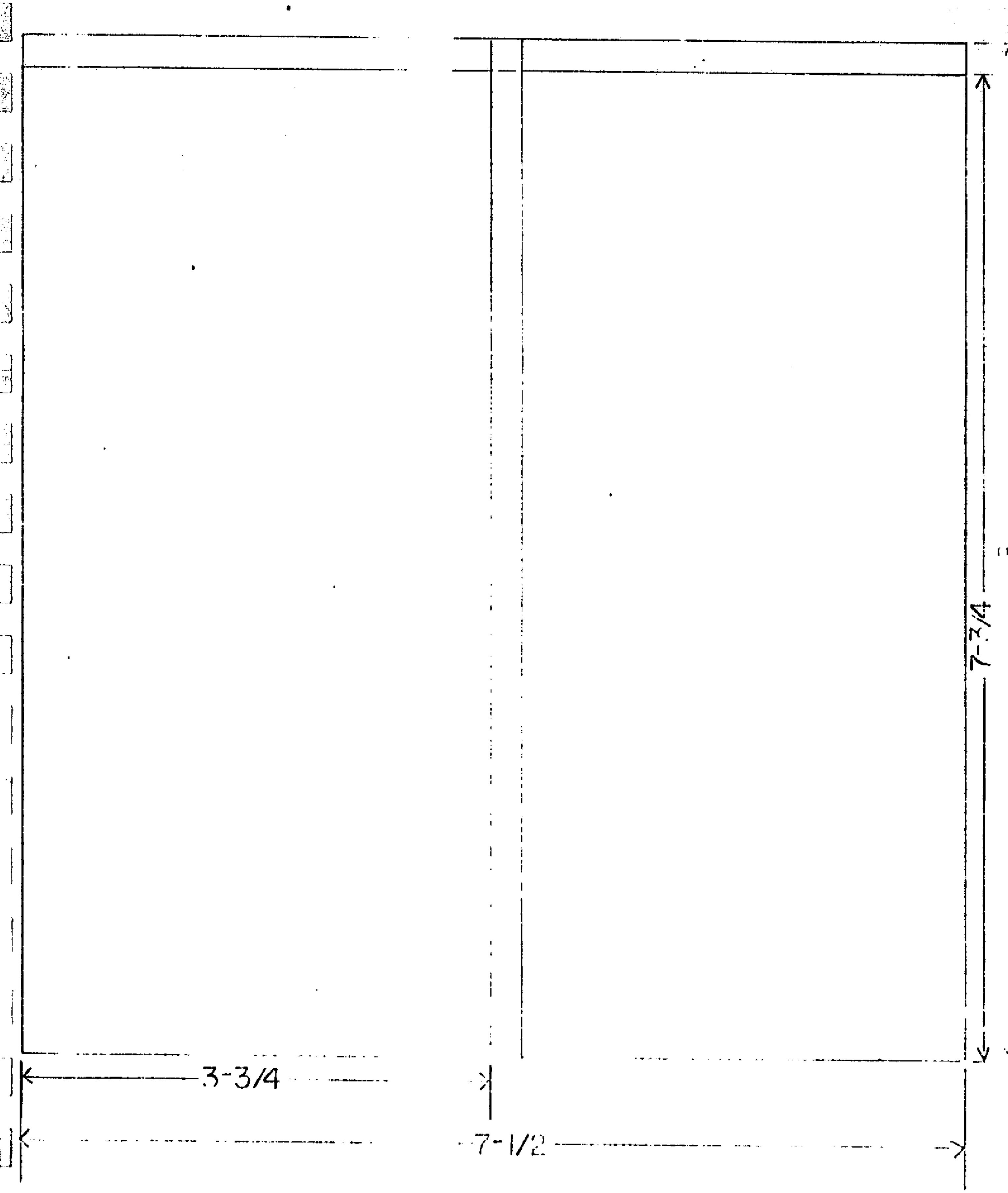
prm



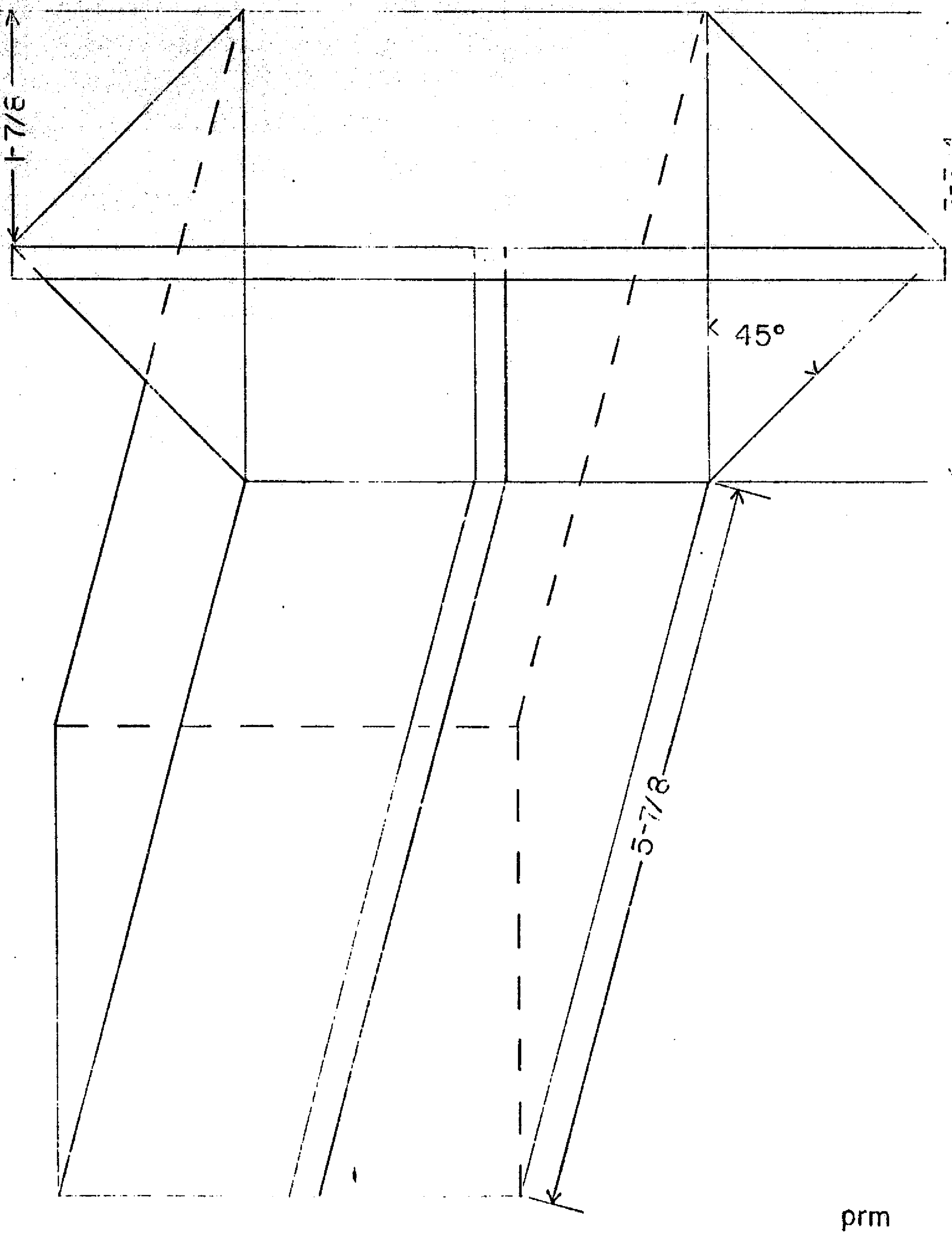
prm



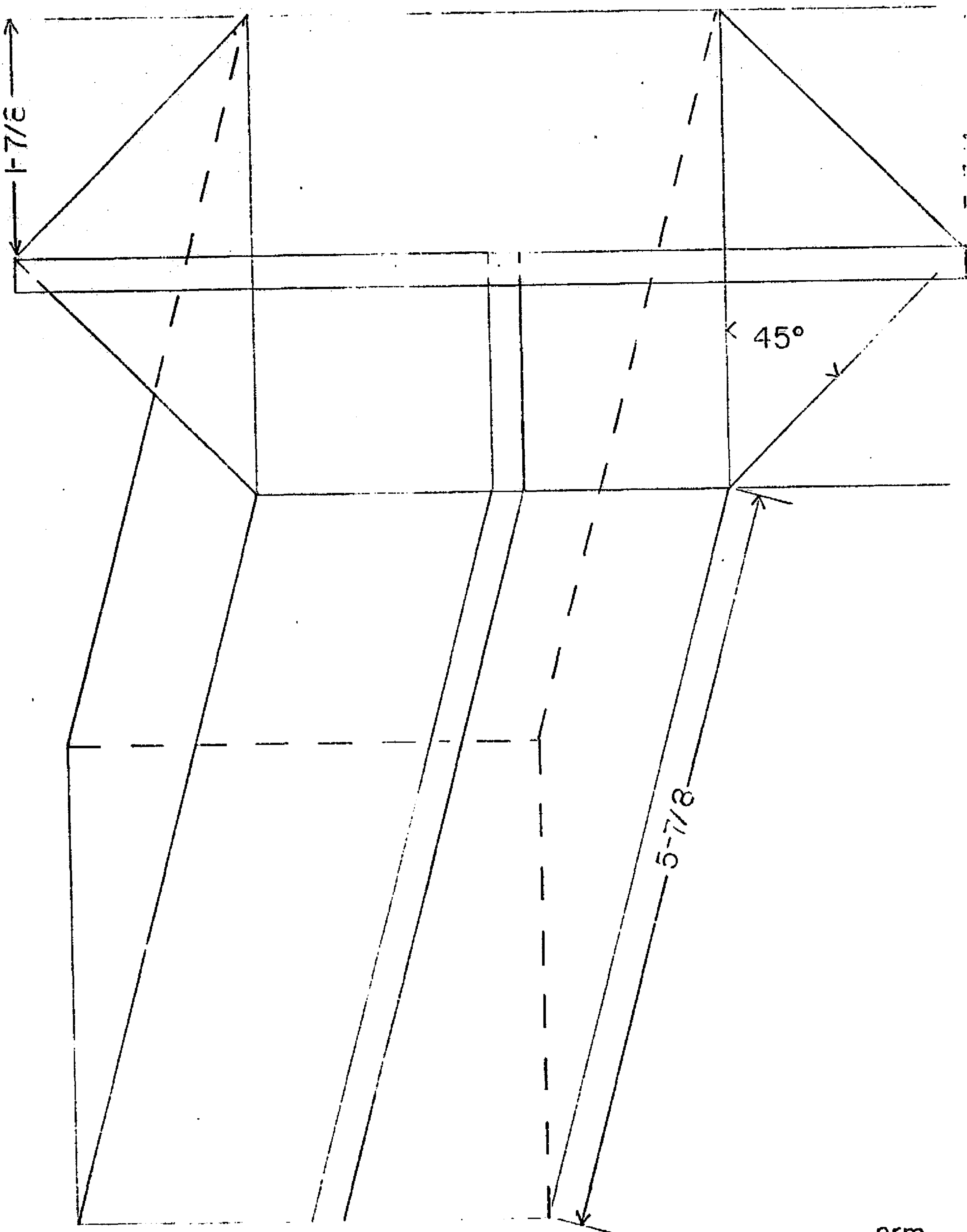
prm



prm



prm



prm

PACKAGING MATERIAL SPECIFICATION (PMS)

NAME: Pressure Sensitive Base Tape

CODE	ISSUE	DATE
300		
SUPERSEDES		PAGE

DIMENSIONS: ________ CONDITIONS OF USE: ________

FOOD TYPE : ________

CLASS : ________ GEN SPEC ________

ITEM	CHARACTERISTIC	TP NO	STANDARD	TOLERENCE ACTION

INTRODUCTION:

Intended use of bottom tape herein specified will not bring them into contact with food. The tape will be used to secure the ears of a pouch which is extending through a rigid base.

DESIGN:

Dimensions

Length	3 1/8"	± 1/64
Width	3 1/8"	± 1/64

MATERIAL:

Structure (outside to inside)

White semi-rigid vinyl	.0038"	± .0002"
Permanent transparent acrylic adhesive (backed with)	.0007"	
Semi bleached Kraft paper with release coating	.0033"	± .0002"
Total Thickness	.0078"	± .0004"

REFERENCE MATERIALS:
As per Fasson's semi-rigid S-type vinyl (Fas Cal 5505) with permanent adhesive #S277 on 50# fast release liner.

PRINTING: None

SHIPPING AND STORAGE DIRECTIONS: ________

APPROVALS ________

PACKAGING MATERIAL SPECIFICATION (PMS)

NAME: RTV 102
Silicone Rubber
Adhesive/Sealant

CODE	ISSUE	DATE
400		
SUPERSEDES		PAGE

DIMENSIONS:

CLASS :

CONDITIONS OF USE:

FOOD TYPE :

GEN SPEC

ITEM	CHARACTERISTIC	TP NO	STANDARD	ACTION	TOLERENCE

INTRODUCTION:

The intended use of this material will not bring it into direct contact with food but is a component of a total food package. Therefore, the material must be nontoxic and non flammable. The material will be used as a sealant for the injection of water into a pouch.

MATERIAL:

General Electric RTV 102 white silicone rubber adhesive/sealant.

APPROVALS

PACKAGING MATERIAL SPECIFICATION (PMS)

NAME: Pressure Sensitive Label

CODE	ISSUE	DATE
500		
SUPERSEDES		PAGE

DIMENSIONS:

CLASS :

CONDITIONS OF USE:

FOOD TYPE :

GEN SPEC

ITEM	CHARACTERISTIC	TP NO	STANDARD	ACTION	TOLERENCE

INTRODUCTION:

Intended use of labels herein specified will not bring them into contact with food. Labels will be used to identify product and secure top flaps on package.

DESIGN:

	Standard	Tolerence
Length	3 1/2"	± 1/64
Width	1 1/2"	± 1/64

MATERIAL:

Structure (outside to inside)

	Standard	Tolerence
White polypropylene	.0032"	± .0002"
Removable rubber based adhesive (backed with)	.0007"	
Semi bleached Kraft paper with release coating	.0033"	± .0002"
Total	.0072"	± .0004"

REFERENCE MATERIALS:

As per Fasson's syntique with removable adhesive #R130 on 50# fast release liner.

PRINTING: None

SHIPPING AND STORAGE DIRECTIONS:

APPROVALS

THE PILLSBURY COMPANY

Do not circulate this specification outside The Pillsbury Company

PRODUCT SPECIFICATION

FORM #2896 (4/73)

PACKAGING INFORMATION

SECTION

CODE	ISSUE	DATE
SUPERSEDES		PAGE

ITEM	DESCRIPTION	CODE	SIZE	UNIT USAGE
	Rigid Base	100	4" x 4" x 7/8"	
	H-Bottom Pouch	200	As Specified	
	Base Tape	300	3 1/8 x 3 1/8	
	RTV 102	400		
	Label	500	3 1/2" x 1 1/2"	

ASSEMBLY INSTRUCTIONS

A) One pouch (200) is positioned in the rigid base (100) such that the sealed ears are inserted into the base slots. The ears are then laid flush to the bottom of the base and then adhered down by using the base tape (300).

B) RTV 102 (400) is then injected into the needle insertion hole. The RTV 102 (400) is to be at least 3/16" minimum thick over entire area of hole.

C) The package is then filled, formed, vacuumed, and sealed. The top seal line is to be perpendicular to the line adjoining the needle insertion hole and the indexing notch. The seal area is to be laid flat against filled portion away from needle insertion hole. Pouch material over-hanging the base is then folded inward and laid in a flat position against filled pouch. Label (500) is then applied over this area to hold material secure for square appearance.

APPROVALS

PROCESS FLOW DIAGRAM

1 Sheet of material (PMS #200) 15 1/2" x 8"

↓

Fold in half and side seal made

↓ Drawing #1

Position seam at center of face and seal bottom

↓ Drawing #2

Place pouch on Mandrel with side seam centered down side of Mandrel opposite indexing notch and needle insertion hold. Ears will form. Cut ends of ears off allowing no air bubbles to form during sealing. Seal ears completely.

↓

Heat pouch with hot air gun so that it conforms to Mandrel shape.

↓

Base material (PMS #100) is thermoformed into 4" x 4" x 7/8" shape → Base tray (PMS #100) is trimmed and slots cut → Hole is drilled into corner →

Base tray (PMS #100) is placed over pouch on Mandrel such that pouch ears are led through base slots and indexing notch and needle insertion hole are properl indexed on Mandrel. Base tape (PMS #300) is then applied over ears and tray base.

↓

RTV sealant (PMS #400) is then applied through needle insertion hole such that sealant is 3/16" minimum thickness over entire area of hole and sealant is in contact with both base tray and pouch.

↓

Package is removed from Mandrel

↓

Package filled, formed

Package vacuumed and sealed such that top seal line is to be perpendicular to the line adjoining the needle insertion hole and the indexing notch.

↓

The sealed top is then folded such that top is laid flat against filled portion away from needle insertion hole. Pouch material now overhanging the base tray is then folded inwards and laid in a flat position against filled pouch. Label (PMS #500) is then applied over folded flaps to secure package.

Space Shuttle
Prototype Package
Demonstration Soup
Specification Guide No. 1

SPLIT PEA WITH HAM SOUP

1.0 SCOPE

1.1 This document describes the processing required to produce a Split Pea with Ham Soup suitable for demonstrating rehydration and feeding from the Fairchild-Pillsbury prototype Space Shuttle demonstration package.

2.0 APPLICABLE DOCUMENTS

U.S. Department of Health Education and Welfare

Federal Food, and Drug and Cosmetic Act and Regulation Promulgated Thereunder.

U.S. Department of Agriculture Consumer and Marketing Service, Meat Inspection Act, and Regulation promulgated thereunder pertaining to the inspection of red meats.

U.S. Department of Agriculture

Regulations Governing the Inspection of Vegetable and Legumes and United States Specification of Classes Standards and Grades with respect thereto.

3.0 REQUIREMENTS

3.1 Materials

The product soup shall be manufactured from components which comply with the regulation of the

Food and Drug Administration, U.S. DPHEW and regulations of Consumer Marketing Service, USDA. All materials shall be of edible grade, clean, sound and wholesome and shall be free of evidence of insect infestation or foreign matter, odors and flavors. Materials shall be in excellent condition and will comply with grade standards at the time of processing.

3.1.1 Peas, Split, Green Dried

Split peas shall be No. 1 grade, free of foreign material and shall be sound, wholesome and clean.

3.1.2 Water

Potable water from an approved municipal water supply shall be used.

3.1.3 Smoked Sausage

Lightly smoked pork sausage shall be used.

3.1.4 Onions, Diced

Fresh bermuda or yellow onion, No. 1 grade shall be used. Onion must be sound and free of soft, or dried areas. Onions must be coarsley chopped to 1 cm dice or less and must be free of mold.

3.1.5 Celery

Fresh, No. 1 fancy grade celery with leaves and mid-rib portion shall be used. Celery shall be chopped into 1 cm dice or less.

3.1.6 Carrots

Fresh, No. 1 fancy carrots trimmed of green areas and excessive pithy cores shall be used. Carrots shall be chopped into 1 cm dice or less.

3.1.7 Ham

Lightly smoked ham sliced into 2mm slices, then into 1 cm dices shall be used.

3.1.8 Salt

Non-iodized and non-fillered salt at 97% or greater NaCl shall be used.

3.1.9 Garlic

Fresh garlic cloves, peeled and trimmed of discolored spots and bud ends must be used.

3.1.10 Bay Leaves

Dried bay leaves sound and free of extraneous matter must be used.

3.1.11 Sugar

Granulated cane or beet sugar at 99% or greater sucrose must be used.

3.1.12 Pepper

Fancy malabar black pepper, 100% to pass a USBS #14 sieve shall be used.

3.1.13 Thyme

Dried thyme, 100% to pass a USBS #8 sieve shall be used.

3.1.14 Butter

Sweet creamery butter, 92 score or better shall be used.

3.1.15 Flour

Enriched wheat flour, all purpose shall be used.

3.1.16 Formula

The following formula shall be used:

Ingredient	Percent by Weight
Peas, split, green	16.62372
Water	59.84539
Smoked sausage	5.19491
Onion, fresh diced	2.65979
Celery, fresh diced	5.48582
Carrots, fresh diced	2.78447
Ham, sliced, diced	4.07282
Salt	0.83120
Garlic	0.16623
Bay leaves	0.02080
Sugar	0.20780
Pepper, malabar	0.01664
Thyme	0.01246
Butter	1.24678
Flour	0.83113
	100.00000

3.2 Processing

3.2.1 Soup

Soak peas in water 16 hours at 4°C maximum temperature. Add sausage and bring temperature up to 100°C. Hold at a gentle simmer for 90 minutes. During the last 30 minutes constant

stirring may be necessary to avoid scorching. Remove sausage and discard it. Add vegetables, salt, sugar, flavorings and return to boiling then simmer 30 minutes longer with constant stirring. Process rapidly through a 3mm round plate to puree mixture. Prepare a roux from the butter and flour. Add the puree to it with constant stirring to avoid lumps and raise temperature to 100°C. Add ham pieces with constant stirring. Hold temperature at 100°C for 10 minutes more.

3.2.2 Molding

The Split Pea with Ham Soup shall be rapidly apportioned among food-compatible plastic molds measuring 10.2 x 10.2 x 1.27 cm and having edges and corners of a radius of curvature of 1 cm. Apportioned weight shall be 150 ± 5 gm. This will result in 50 ± 5g dry weight.

3.2.3 Freezing

The molded soup shall be rapidly frozen in a plate freezer immediately after molding to an internal temperature of not more than -5°C.

3.2.4 Freeze Dehydration

Do not unmold soups. The frozen soups shall be placed on suitable racks in a freeze dryer so that a 1 cm space exists between the platen and the soup. The platen temperature shall be 50.0°C ± 2°C. The internal pressure shall be

not greater than 200 μM of Hg. (An electronic transducer-type meter shall be used to monitor drying during processing, but this instrument shall be calibrated against a mercury-in-glass gauge, such as a McLeod gauge.) Dehydration shall be deemed complete when the internal temperature of the molded soup reaches 25°C at 200 μM of Hg. pressure. Vacuum shall be broken with dry nitrogen gas or argon gas of a grade suitable for contact with foods.

3.2.5 Packaging

The molded, freeze-dehydrated soup shall promptly be packaged. The un-molded soup shall be carefully placed in the pre-formed prototype package. The package shall be placed in the packaging jig (part No. RD008G2903) with the side fin-seal in the mid-line between the doors. The sides of the package are drawn outward to form a modified gusset fold and the doors are brought down to form a flat configuration of the package walls. The jig is placed in the rack of the packaging machine and run fully to the rear stop. The package walls will be normal to the sealing bar at this point. A vacuum of not more than 1.0 mm Hg. shall be drawn, and a sound seal effected. The fins are trimmed and folded downward and held in place with an adhesive label.

CHICKEN AND RICE SOUP

1.0 SCOPE

1.1 This document describes the processing required to produce a Chicken and Rice Soup suitable for demonstrating rehydration and feeding from the Fairchild-Pillsbury prototype Space Shuttle demonstration package.

2.0 APPLICABLE DOCUMENTS

U.S. Department of Health Education and Welfare Federal Food Drug and Cosmetic Act and Regulations Promulgated Thereunder.

U.S. Department of Agriculture

Poultry Products Inspection Act.

United States Specification of Cl.sses, Standards and Grades with Respect Thereto.

U.S. Department of Agriculture

Regulation Governing the Inspection of Vegetables and Legumes and United States Specification of Classes, Standards and Grades with Respect Thereto.

3.0 REQUIREMENTS

2.1 Materials

The product soup shall be manufactured from components which comply with the regulations

of the Food and Drug Administration, U.S. DPHEW and regulations of Consumer Marketing Service, USDA. All materials shall be of edible grade, clean, sound and wholesome and shall be free of evidence of insect infestation, or foreign matter, or foreign odors or flavors. Materials shall be in excellent condition and comply with grade standards at the time of processing.

3.1.1 Chicken

U.S. Grade B or better stewing hens only shall be used for preparation of chicken stock and for white chicken meat.

3.1.2 Salt

Salt shall be 97.0% or greater NaCl and shall not be iodized or fillered.

3.1.3 Rice

Uncooked, fancy, long grain polished white rice shall be used.

3.1.4 Chicken Stock

Chicken stock shall be essentially fat free and must be used within 8 hours of processing (see 3.2.2).

3.1.5 Pepper

Fancy Malabar black pepper, 100% to pass a USBS #14 sieve shall be used.

3.1.6 Seasonings

Dried Thyme and Fresh U.S. Fancy Celery leaves shall be used as seasoning ingredients.

3.1.7 Chicken Bouillon Cubes

High quality chicken flavored bouillon cubes shall be used.

3.1.8 Parsley

Fresh U.S. Fancy Parsley shall be used.

3.1.9 Formula

The following formula shall be used:

Ingredient	Percent by Weight
Chicken Stock	75.46
Chicken cooked, diced	11.07
Rice	10.56
Bouillon Cubes, chicken	1.61
Salt	0.96
Parsley	0.27
Pepper	0.07
	100.00

3.2 Processing

3.2.1 Chicken

The chicken shall be cooked in water for two hours. (Suggested rate is 1.25 Kgm chicken in 2 l water. Chicken may be cut-up or whole. Bring cool water with chilled chicken in it to a rapid boil, reduce heat and simmer 2 hours). The cooled chicken meat shall be drained and rapidly chilled to 2°C ± 2°C in a refrigerator. The *Pectoralis major* and *Pectoralis minor* muscles shall be excised with no skin adhering and rapidly reduced to

a 1 cm. dice. Do not permit meat temperature to exceed 4°C. Insure that no bones, bone fragments or cartilage contaminates the chicken meat.

3.2.2 Chicken Stock

The stock remaining after the chicken is removed shall be rapidly cooled under refrigeration to permit separation of the fat layer. The salt, pepper and bouillon cubes are added to the defatted stock. Flavorings at a rate of 10% for celery leaves and stalks and at a rate of 0.04% for thyme shall be simmered in the stock for 20 to 25 minutes. The celery is removed by straining upon completion of the cook.

3.2.3 Finishing

The rice shall be added directly to the hot stock and the temperature returned to a gentle simmer. Cook until the rice is tender for 15-20 minutes. Add diced chicken meat, allow temperature to recover to 100°C and hold for 10 minutes.

3.2.4 Molding

The Chicken and Rice Soup shall be rapidly apportioned among food-compatible plastic molds measuring 10.2 x 10.2 x 1.27 cm and having edges and corners of a radius of curvature of 1 cm. Apportioned weight shall

be 90.0 gm $\pm$ 2.0 gm. This will result in 22 $\pm$ 2 g dry weight.

3.2.5 <u>Freezing</u>

The molded soup shall be rapidly frozen in a plate freezer immediately after molding to an internal temperature of not more than -5°C.

3.2.6 <u>Freeze Dehydration</u>

The frozen soups shall be unmolded and placed on suitable racks in a freeze dryer so that a 1 cm space exists between the platen and the soup. The platen temperature shall be 50.0°C $\pm$ 2°C. The internal pressure shall be not greater than 200 µM of Hg. (An electronic transducer-type meter shall be used to monitor drying during processing, but this instrument shall be calibrated against a mercury-in-glass gauge, such as a McLeod gauge). Dehydration shall be deemed complete when the internal temperature of the molded soup reaches 25°C at 200 µM of Hg. pressure. Vacuum shall be broken with dry nitrogen or argon gas of a grade suitable for contact with foods.

3.2.7 <u>Packaging</u>

The molded, freeze-dehydrated soup shall be promptly packaged. The molded soup shall

be carefully placed in the pre-formed prototype package. The package shall be placed in the packaging jig (part No. RD008G2903) with the side fin-seal in the mid-line between the doors. The sides of the package are drawn outward to form a modified gusset fold and the doors are brought down to form a flat configuration of the package walls. The jig is placed in the rack of the packaging machine and run fully to the rear stop. The package walls will be normal to the sealing bar at this point. A vacuum of not more than 1.0 mm Hg. shall be drawn, and a sound seal effected. The fins are trimmed and folded downward and held in place with an adhesive label.

Space Shuttle
Prototype Package
Demonstration Soup
Specification Guide No. 3

CREAM OF TOM SOUP

1.0 SCOPE

1.1 This document describes the processing required to produce a Cream of Tomato Soup suitable for demonstrating rehydration and feeding from the Fairchild-Pillsbury prototype Space Shuttle demonstration package.

2.0 APPLICABLE DOCUMENTS

U.S. Department of Health Education and Welfare. Federal Food Drug and Costmetic Act and Regulation Promulgated thereunder.

U.S. Department of Agriculture Regulation regulating the inspection of Vegetables and U.S. Specification of Classes, Standards and Grades with respect thereto.

3.0 REQUIREMENTS

3.1 Materials

The product soup shall be manufactured from components which comply with the regulations of the Food and Drug Administration, U.S. DPHEW and regulations of the U.S. Department of Agriculture. All materials shall be of edible grade, clean, sound and wholesome and shall be free of evidence of insect infestation,

or foreign matter or foreign odors or flavors. Materials shall be in excellent condition and must comply with suitable grade standards at the time of processing.

3.1.1 Butter

Sweet creamery butter scoring 92 or better shall be used.

3.1.2 Flour

All purpose wheat flour shall be used.

3.1.3 Milk, Whole, Liquid

Whole pasteurized and homogenized 3.5% butter fat shall be used.

3.1.4 Tomato Paste

Fancy tomato paste of at least 25% solid matter and containing no scorched specks shall be used.

3.1.5 Tarragon

Dried tarragon leaves shall be used.

3.1.6 Formula

The following formula shall be used:

Ingredient	Percent by Weight
Butter	5.85
Flour	3.90
Milk	46.82
Tomato Paste	43.40
Tarragon	0.03
	100.00

3.2 Processing

3.2.1 Soup Preparation

Make a roux of the butter and flour. Slowly add milk with stirring to avoid lumps. When smooth and simmering, stir in tomato paste until smooth. Add tarragon. Bring temperature to 100°C and hold 10 minutes with constant stirring.

3.2.2 Molding

Immediately apportion Cream of Tomato soup among food compatible plastic molds measuring 10.2 x 10.2 x 1.27 cm and having edges and corners of a radius of curvature of 1 cm. Apportioned weight shall be 105 ± 5 g. This will result in 32 ± 2 g dry weight.

3.2.3 Freezing

The molded soup shall be rapidly frozen in a plate freezer immediately after molding to an internal temperature of not more than -5°C.

3.2.4 Freeze Dehydration

The frozen soups shall be placed on suitable racks in a freeze dryer so that a 1 cm space exists between the molds and the platen and the soup. The platen temperature shall be 50.0°C ± 2°C. The internal pressure shall be not greater than 200 μM of Hg. (An electronic

transducer-type meter shall be used to monitor drying during processing, but this instrument shall be calibrated against a mercury-in-glass gauge, such as a McLeod gauge). Dehydration shall be deemed complete when the internal temperature of the molded soup reaches 25°C at 200 µM of Hg. pressure. Vacuum shall be broken with dry nitrogen gas or argon gas of a grade suitable for contact with foods.

3.2.5 Packaging

The unmolded, freeze dehydrated soup shall promptly be packaged. The soup mold shall be carefully placed in the pre-formed prototype package. The package shall be placed in the packaging jig (part No. RD008G2903) with the side fin-seal in the mid-line between the doors. The sides of the package are drawn outward to form a modified gusset fold and the doors are brought down to form a flat configuration of the package walls. The jig is placed in the rack of the packaging machine and run fully to the rear stop. The package walls will be normal to the sealing bar at this point. A vacuum of not more than 1.0 mm Hg. shall be drawn, and a sound seal effected. The fins are trimmed and folded downward and held in place with an adhesive label.

CREAM OF POTATO SOUP

1.0 SCOPE

1.1 This document describes the processing required to produce a Cream of Potato Soup suitable for demonstrating rehydration and feeding from the Farichild-Pillsbury prototype Space Shuttle demonstration package.

2.0 APPLICABLE DOCUMENTS

U.S. Department of Health Education and Welfare

Federal Food Drug and Cosmetic Act and Regulation Promulgated thereunder.

U.S. Department of Agriculture

Regulation regulating the inspection of Vegetables and U.S. Specification of Classes, Standards and Grades with respect thereto.

3.0 REQUIREMENTS

3.1 Materials

The product soup shall be manufactured from components which comply with the regulations of the Food and Drug Administration, U.S. DPHEW and regulations of the U.S. Department of Agriculture. All materials shall be of edible grade, clean, sound and wholesome and shall be free of evidence of insect infestation, or foreign matter or foreign odors or flavors.

Materials shall be in excellent condition and must comply with suitable grade standards at the time of processing.

3.1.1 Potatoes, Diced

White Potatoes shall be U.S. No. 1 grade, Irish Cobbler variety or equivalent and shall be pared, eyed and free of all green coloration, splits or soft areas. They shall be washed under cool running water and diced into 1 cm cubes.

3.1.2 Onions, Diced

U.S. No. 1 grade yellow onions shall be used. They shall be peeled, the dense root section removed and shall be reduced to a 1 cm dice.

3.1.3 Celery

U.S. No. 1 fancy celery mid-ribs and leaves shall be reduced to approximately 1 cm slices.

3.1.4 Water

Potable water from an approved municipal water supply shall be used.

3.1.5 Salt

Salt of 97% or greater NaCl, un-iodized and un-fillered shall be used.

3.1.6 Bay Leaves

Dried bay leaves, sound and free of insect damage shall be used.

3.1.7 Butter

Sweet creamery butter scoring 92 or better shall be used.

3.1.8 Flour

All purpose wheat flour shall be used.

3.1.9 Milk, Whole, Liquid

Whole pasteurized and homogenized 3.5% butter fat milk shall be used.

3.1.10 Formula

The following formula shall be used:

Ingredients	Percent by Weight
Potatoes, diced	30.51
Onions, diced	6.44
Celery, diced	8.58
Water	45.77
Salt	0.57
Bay leaves	.02
Butter	1.43
Flour	.95
Milk, whole	5.73
	100.00

3.2 Processing

3.2.1 Soup Preparation

Add potatoes, onions, celery, salt and bay leaves to cool water and rapidly bring to a boil. Reduce heat and simmer until potatoes mash easily. Remove bay leaves. Puree the soup through a 3mm dish. Make a roux with the butter and flour. Add puree slowly with constant stirring to make a smooth soup. Return temperature to 100°C and hold 10 minutes. Remove from heat and add milk with stirring.

3.2.2 Molding

Immediately apportion Cream of Potato Soup among food-compatible plastic molds measuring 10.2 x 10.2 x 1.27 cm and having edges and corners of a radius of curvature of 1 cm. Apportioned weight shall be 150 $\pm$ 5 g. This will result in 22 $\pm$ 2 g dry weight.

3.2.3 Freezing

The molded soup shall be rapidly frozen in a plate freezer immediately after molding to an internal temperature of not more than $-5^{o}C$.

3.2.4 Freeze Dehydration

The frozen soups shall be placed on suitable racks in a freeze drier so that a 1 cm space exists between the molds and the platen and the soup. The platen temperature shall be $50.0^{o}C$ $\pm$ $2^{o}C$. The internal pressure shall be not greater than 200 μM of Hg. (An electronic transducer-type meter shall be used to monitor drying during processing, but this instrument shall be calibrated against a mercury-in-glass guage, such as a McLeod guage.) Dehydration shall be deemed complete when the internal temperature of the molded soup reaches $25^{o}C$ at 200 μM of Hg. pressure. Vacuum shall be broken with dry nitrogen gas or argon gas of a grade suitable for contact with foods.

3.2.5 Packaging

The unmolded, freeze dehydrated soup shall promptly be packaged. The soup mold shall be carefully placed in the pre-formed prototype package. The package shall be placed in the packaging jig (part No. RD008G2903) with the side fin-seal in the mid-line between the doors. The sides of the package are drawn outward to form a modified gusset fold and the doors are brought down to form a flat configuration of the package walls. The jig is placed in the rack of the packaging machine and run fully to the rear stop. The package walls will be normal to the sealing bar at this point. A vacuum of not more than 1.0 mm Hg. shall be drawn, and a sound seal effected. The fins are trimmed and folded downward and held in place with an adhesive label.

BEEF NOODLE SOUP

1.0 SCOPE

1.1 This document describes the processing required to produce a Beef Noodle Soup suitable for demonstrating rehydration and feeding from the Fairchild-Pillsbury prototype Space Shuttle demonstration package.

2.0 APPLICABLE DOCUMENTS

U.S. Department of Health Education and Welfare

Federal Food Drug and Cosmetic Act and Regulations Promulgated thereunder.

U.S. Department of Agriculture

Federal Meat Inspection Act and Regulations Promulgated thereunder.

3.0 REQUIREMENTS

3.1 Materials

The product soup shall be manufactured from components which comply with the regulations of the Food and Drug Administration, U.S. DPHEW and regulations of Consumer Marketing Service, USDA. All materials shall be of edible grade, clean, sound and wholesome and shall be free of evidence of insect infestation, or foreign matter, or foreign odors or flavors. Materials

shall be in excellent condition and comply with grade standards at the time of processing.

3.1.1 Beef and Beef Bones

U.S. Grade Choice beef cut for stew meat and beef bones, edible grade only shall be used in the preparation of stock for Beef Noodle Soup.

3.1.2 Noodles

Enriched egg noodles, flat style, cooked al dente and drained and chilled to $2^{o}C \pm 2^{o}C$ shall be used.

3.1.3 Beef Bouillon Cubes

Beef bouillon cubes of high quality shall be used.

3.1.4 Pepper

Fancy Malabar black pepper, 100% to pass a USBS #14 sieve shall be used.

3.1.5 Potatoes

U.S. Grade No. 1, Irish Cobbler or equivalent white, peeled and eyed shall be used, trimmed of any green coloration.

3.1.6 Formula

The following formula shall be used.

Ingredient	Percent by Weight
Beef Stock	56.64
Beef, cubes	18.88
Noodles	22.65
Bouillon Cubes	1.21
Salt	.56
Pepper	.06
	100.00

3.2 **Processing**

3.2.1 **Beef**

Beef cubes of 1 cm shall be prepared trimmed of extraneous fat and connective tissue and free of bone fragments, cartilige and tendons.

3.2.2 **Beef Stock**

Beef stock shall be prepared by cooking beef bones (at a rate of 1 Kgm beef bones per liter of cool water). Include vegetables at a rate based on bone weight; 17% celery, 12% carrots and 20% potatoes. Boil up, reduce heat and simmer for 2 hours. Strain bones and vegetables. Chill rapidly to $2^{o}C \pm 2^{o}C$ to freeze floating fat and skim it off.

3.2.3 **Finishing**

Return Beef Stock to heat and rapidly raise temperature to $100^{o}C$. Add beef cubes, boil up and simmer 20-25 minutes until meat is tender. Skim off foam. Add cooked noodles, return to 100^{o} and hold temperature for 10 minutes.

3.2.4 **Molding**

The beef and noodle soup shall be rapidly apportioned among food compatible plastic molds measuring 10.2 cm x 10.2 cm x 1.27 cm and having edges and corners of a radius of curvature of 1.0 cm. Apportioned wieght shall be 170 gm $\pm$ 5.0 gs. This will result in 24 $\pm$ 4 g dry weight.

3.2.5 Freezing

The molded soup shall be rapidly frozen in a plate freezer immediately after molding to an internal temperature of not more than -5°C.

3.2.6 Freeze Dehydration

Do not unmold soups. The frozen soups shall be placed on suitable racks in a freeze dryer so that a 1 cm space exists between the platen and the soup. The platen temperature shall be 50.0°C $\pm$ 2°C. The internal pressure shall be not greater than 200 µM of Hg. (An electronic transducer-type meter shall be used to monitor drying during processing, but this instrument shall be calibrated against a mercury-in-glass guage, such as a McLeod guage.) Dehydration shall be deemed complete when the internal temperature of the molded soup reaches 25°C at 200 µM of Hg. pressure. Vacuum shall be broken with dry nitrogen gas or argon gas of a grade suitable for contact with foods.

3.2.7 Packaging

The molded, freeze-dehydrated soup shall promptly be packaged. The un-molded soup shall be carefully placed in the pre-formed prototype package. The package shall be placed in the packaging jig (part No. RD008G2903) with the side fin-seal in the mid-line between the doors. The sides of the package are drawn

outward to form a modified gusset fold and the doors are brought down to form a flat configuration of the package walls. The jig is placed in the rack of the package machine and run fully to the rear stop. The package walls will be normal to the sealing bar at this point. A vacuum of not more than 1.0 mm Hg. shall be drawn, and a sound seal effected. The fins are trimmed and folded downward and held in place with an adhesive label.

TABLE OF CONTENTS

1.0 SCOPE

The rehydratable food package is the primary food package used for crew food consumption during Shuttle orbiter missions. This document established the functional, physical and performance interface requirements between the package and the galley water system. It also establishes the functional requirements of the package with respect to the crewman. It is intended to control the configuration and design of the applicable interfacing items to maintain compatibility between co-functioning and physically mating items and to assure those performance criteria that are dependent upon the interfacing system.

2.0 APPLICABLE DOCUMENTS

2.1 Government Documents

The following documents of the exact issue shown form a part of this document to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this document, the contents of this document shall be considered a superseding requirement.

National Aeronautics and Space Administration/Johnson Space Center (NASA/JSC)

SE-S-0073A	Specification, Space Shuttle Fluid, Procurement and Use Of
SD-W-0020	Potable Water Specification

(TBD)	Specification, Galley Food Management
(TBD)	Procedure, Pre-Flight/Installation, Galley Operation

2.2 Non-Government Documents

The following documents of the exact issue shown form a part of this document to the extent specified herein.

Specifications:

The Pillsbury Company

TBD	Package Sleeve
TBD	Package Base
TBD	Package Septum Material
TBD	Assembly Adhesive Tape
TBD	Label
TBD	Assembly

3.0 REQUIREMENTS

3.1 Functional

The Shuttle Orbiter galley water system shall supply two constant sources of potable water, heated and chilled to the rehydratable packages through the package septum.

3.1.1 Flow

Both hot and chilled water sources shall be supplied at a minimum flow of 60#/hr. The demand for both water sources will be intermittent and is defined under 3.3.

3.1.2 Temperature

Hot water shall be supplied at a temperature of 155 - 165°F. Chilled water shall be supplied at a temperature of 45 - 55°F. An allowance will be made for that initial volume of water between the interfacing coupling and the chiller which would tend to be warmed to ambient temperature when the chilled water system is not operated. In order to minimize this condition, that volume of water shall be held to 25cc maximum.

3.1.3 Pressure

Pressure of both water sources at the flow requirements per 3.1.1 shall be $10 ^{+7}_{-2}$ psig.

3.1.4 Water Quality

The quality of both the ambient and chilled water supplies to the galley shall meet the standards of SE-S-0073 and SD-W-0020. In addition, the volume of any undissolved gas entrained in the water supplied shall not exceed 4% of the water volume.

3.1.5 Package Capacity

The package shall be sized and configured to accept incoming water without major volume changes.

3.1.6 Package Opening

The package shall be cut open beneath the top seal with side walls in vertical position for dining.

.7 Dining

The galley dining tray shall retain the package base in a manner that will allow the crewman to use the package as his primary eating container.

3.2 Physical

3.2.1 Package Pressure

The package shall maintain an internal pressure of less than 50 mm Hg. for a minimum of 1 year. The galley rehydration device shall cause no internal leakage of air on penetration.

3.2.2 Package Septum

The package septum shall be configured in one corner. At the point of insertion, the septum material shall be .125"-.25" thick.

3.2.3 Provision for Misalignment

The package base shall have an alignment feature (keyway) directly opposed to the package septum. The galley water system shall have a mating key to prevent inadvertent punctures to the package.

3.3 Performance

3.3.1 Package Retention

The galley shall provide a positive locking means to retain the package during insertion and rehydration.

3.3.2 Water Quantities

The galley water system hot and chilled water sources shall supply water within those functional requirements specified in 3.1 consistent with the demands of the galley water systems as defined in the following paragraphs.

3.3.2.1 Flow Demand

Continuous flow demands for the galley water system are dependent on the particular food/beverage package to be rehydrated and the number of packages involved at any one meal. There is also a requirement for drinks at any time between regular meals. Continuous flow demands should not exceed 8 ounces (max. requirement for any food/beverage package). Accumulative intermittent demand at maximum meal is as follows:

3.3.2.2 Peak Demand

The peak demands as follows are accumulated intermittent demands for the individual food/beverage packages required to make up a maximum meal for a seven man crew. In the event of a ten man crew it is anticipated that they will eat in shifts, and will not impact these flow demands. The accumulated time is that required from initial water dispensed to last water dispensed for that meal.

Hot Water

Total quantity for meal	15.45#
Accumulated time for water demand	23.42 minutes

Chilled Water

Total quantity for meal	16.78#
Accumulated time for water demand	22.84 minutes

3.3.2.3 Nominal Demand

The following specifies the nominal daily demand

for both hot and chilled water systems for a seven man crew.

Hot	22.71#
Chilled	18.07#

3.3.2.4 Maximum Peak Demand

The maximum peak demands represent the accumulation of all the snacks and overage per day added to the maximum meal as in 3.3.1.2. This is defined as an absolute maximum demand.

Hot

Quantity	20.59#
Accumulated Time	31.21 minutes

Chilled

Quantity	23.3#
Accumulated Time	31.71 minutes

3.3.3 Environments

The rehydration packages as stowed in the galley shall meet the functional and performance requirements of this document after being subjected to the storage, checkout and flight environments (TBD Para. # 5) of the galley specifications (TBD Document #).

4.0 VERIFICATION

Each interface requirement listed in Section 3.0 shall be verified by either analysis, assessment, test, or a combination of these. The specific method is given in the Verification Matrix, Table I.

5.0 PRESERVATION AND PACKING

See package specifications (TBD Spec. # 5).

TABLE I. VERIFICATION MATRIX

Section 3 Requirements	Analysis	Assessment: Similarity	Assessment: Review of Design or Applicable Dwg.	Assessment: Inspection	Test: Mock-Up	Test: First Unit Installation Check Out
3.1 Function						
3.1.1	X					
3.1.2	X					X
3.1.3	X					X
3.1.4	X					X
3.1.5	X			X		X
3.1.6	X			X		X
3.1.7	X			X		X
3.2 Physical						
3.2.1	X			X		
3.2.2	X		X	X		
3.2.3	X		X	X	X	X
3.3 Performance						
3.3.1	X		X	X	X	X
3.3.2						X
3.3.2.1	X					
3.3.2.2	X					
3.3.2.3	X					
3.3.2.4	X					